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FRANCIS E. WALTER DAM, LEHIGH RIVER BASIN, LEHIGH RIVER, PENNSY--ETC(U)
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LEHIGH RIVER BASIN

LEHIGH RIVER, PENNSYLVANIA

FRANCIS E. WALTER DAM

CONDITION REPORT

DAM, OUTLET WORKS & SPILLWAY

PERIODIC INSPECTION REPORT NO. 3

NOVEMBER 1976

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE - 2D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

JUNE 1980

COE/NAP/FEWD/PIS/no.3/11-76

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NADEN-TF (3 Jun 77) 1st Ind
SUBJECT: Francis E. Walter Periodic Inspection Report Number 3

DA, North Atlantic Division, Corps of Engineers, 90 Church Street,
New York, NY 10007 1 July 1977

TO: District Engineer, Philadelphia

1. Subject periodic inspection report is approved subject to the following comments:

a. A date for the submission of the report evaluating the seepage at the right abutment should be furnished.

b. The reference to "Appendix E" in para 5.03 should be revised to read "Appendix B".

c. Page 6, para 3.01 - It was suggested during the third periodic inspection that appropriate revisions be made to O&M Manuals to incorporate monitoring and operational recommendations. A statement to this effect should be included in this paragraph.

d. Page 6, para 3.02.C. - Recommendation should be included that boulders removed from outlet channel should be stockpiled for re-use as required. Budget request has not been made in either FY 77 or FY 78 O&M accounts for this work.

FOR THE DIVISION ENGINEER:

Incl wd

F. R. PAGANO
Chief, Engineering Division

CF: w/incl (1 cy)
HQDA (DAEN-CWE-B), Washington, D.C. 20314

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-F

3 June 1977

SUBJECT: Francis E. Walter Periodic Inspection Report Number 3

Division Engineer, North Atlantic
ATTN: NADEN

In accordance with the instructions contained in ER 1110-2-100, "Periodic Inspection and Continuing Evaluation of Civil Works Projects," the subject report is transmitted for your review and approval.

FOR THE DISTRICT ENGINEER:

for WORTH D. PHILLIPS
Chief, Engineering Division

1 Incl (6 cys)
as

INSPECTION & ACTION SUMMARY
PERIODIC INSPECTION REPORT NO.3

Item	Summary of Comment(s)	Action
1. Abutment & Embankment Junctions	Seepage noted on right abutment during 1966 inspection with drought storage pool at el 1390 was observed to stop after the pool was lowered below el 1343. Third inspection no seepage noted.	Seepage measurement weirs & observations in 1966-1967 indicated that seepage is associated with high pools. Seepage observed by dam tender during high pools of 1966 amd 1967.
	Minor seepage on left abutment - toe contact below el 1330 in 3rd inspection.	None required
	Abutment erosion (5-6' deep, 10' wide) along lower one third of downstream left abutment junction noted in 3rd inspection. Minor erosion noted in 2nd inspection.	Repair recommended
	Riprap toe sunken 1'-2' over 150-foot distance along downstream right abutment junction in el 1400 vicinity.	Check and record location of depression for comparison in future inspections.
2. Embankment Vertical & Horizontal Movement	Downstream slope irregularities noted subsequent to first inspection. Upstream slope irregularities observed to also be definitely present in 3rd inspection.	After inconclusive initial 1966 and 1969 surveys, settlement pipes and high elevation piezometers were installed in the downstream slope in 1971. Offset and elevation readings were taken in 1976 which indicated small movements of the downstream slope. A system of surface movement

			observation points was installed on the upstream slope and a schedule of 3 surveys annually was established in the spring of 1977. As a result of the OCE-NAD visit on 4 May 1977 to inspect the slopes and review the program, installation of one slope inclinometer to rock in both upstream and downstream slopes was added to the program. These are currently planned for installation in the summer or fall of 1977.
3.	Outlet Channel	During the 3rd inspection, soundings at end of outlet slab showed the rock surface to vary from 3' (right side to 4' (left side) below top of slab (about the same as previously known).	No action required measurements recorded for reference in future inspections.
		Erosion of right bank of deep scour pool has continued and bank has been over-steepened to the point of becoming a safety hazard. A cobble-boulder shoal has developed downstream of the scour pool.	Dredging of outlet channel and slope flattening performed prior to second periodic inspection. Problem has recurred and cutting back of right side pool slope is required as well as removal of shoal with spoil to be placed on right side downstream.
4.	Conduit concrete surfaces and cracks	Badly cracked and leaking tunnel noted in first periodic inspection. Crack survey recommended in second periodic inspection. Little change noted during third inspection Some leakage observed through the right emergency gate.	Crack survey was made following second periodic inspection. Leaks in operating gate seals stopped by cleaning slots. No further action planned at this time.

5.	Concrete surfaces of spillway	Minor spalling along joints of concrete ogee weir noted during second and third periodic inspection.	Spalls considered surface failures and of no structural concern. No action planned at this time.
6.	Structural details of ogee weir and walls	The upper portion of monolith M-38 of spillway gravity wall at intersection with south spillway levee had been displaced one inch horizontally towards spillway chute at lower construction joint at the time of the second periodic inspection. Some loss of sealant noted in the weir sections during the third inspection.	The monolith displacement increased between 1971 and 1975. The monolith was restored to near original position and drainage behind the wall was improved in the summer of 1975. The repair has proven effective.
7.	Weepholes and drainage system in spillway	Drain holes in downstream apron of ogee weir were found plugged during second periodic inspection.	The drains are 3" ϕ uncapped holes drilled ten feet into rock, which can be cleaned by jetting and rodding. Plugs noted would pop out if back pressure developed in drain.
8.	Service bridge movement	During the summer of 1975, one service bridge exp. bearing rocker was observed to be displaced off the plate.	A separate report, including recommendations, was prepared in Sept.1976 See Appendix D of this 3rd Periodic Inspection Report.
9.	Intake tower equipment-gates and hoist	Minor leakage around west emergency gate noted during third inspection. Access to top of all gates is a safety hazard. A damper for the air intakes on service gates is recommended.	Hazard correction and damper will be considered as funds become available.
10.	Intake tower-concrete	Crack through concrete floor slab above mezzanine level and through slab at downstream side of hatchway to downstream wall of tower noted in the third periodic inspection.	No action is considered necessary at the present.

11.	Intake tower-roof	During the third periodic inspection, cracks and leaks in roof slab at face of hatchway beam were noted. Hairline crack with rust stains on east side of tower below elevation 1300 also noted.	A new roof with a lightweight concrete buildup and possible drain relocation are needed. Work will be done as funds are made available.
12.	Intake tower-elevator	Dam operating personnel reported at the third periodic inspection that the telephone does not consistently function properly and operating problems exist with the elevator itself.	Maintenance is scheduled for the elevator and the phone company has been contacted.
13.	Intake tower-electrical	Defective circuit breaker for lowest floor lights was reported at the third periodic inspection.	Initially replace defective breaker with spare; if problem continues, further study is warranted.
14.	Intake tower-sump pump and by-pass drain	During third periodic inspection, it was reported that the minor problems with the controls occur due to corrosion. Ice was located in the bottom of the elevator shaft.	Recommend installation of heaters in electrical controls and relocate sump pump intake to within 1" from sump bottom.
15.	Intake tower-heating and ventilating system	It was noted during the third periodic inspection that when the main gates are open 8'-10', air is sucked into the building Heat from the furnace does not reach the lowest flcor level.	Furnace replacement or supplemental duct heaters; recommendations: furnish combustion supply air at furnace and supply outside air at bottom level; extend hot air duct as close to lowest floor level as possible and raise elevation of cold air return to elevatic 1290.
16.	Access Road Surface	Pavement surface of road from operations building to LR 40041 is in poor condition.	Resurfacing and other upgrading of road (drainage, base course, repair) scheduled for FY79.

17.	Operations Building heating and ventilating	Heating system deficiencies noted during third periodic inspection.	Installation of new, larger oil burner is scheduled for FY78, Expedient Energy saving measures (temporary plastic storm windows installed during winter 1976-1977.

CONDITION REPORT
FRANCIS E. WALTER DAM
LEHIGH RIVER, PENNSYLVANIA

DAM, OUTLET WORKS AND SPILLWAY

PERIODIC INSPECTION REPORT NO. 3

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dated September 1976

Francis E. Walter Dam
Lehigh River, Pennsylvania
Dam, Outlet Works & Spillway
Periodic Inspection Report No. 3

SECTION 1
INTRODUCTION

1-01. AUTHORITY AND SCOPE. This report has been prepared in accordance with Engineer Regulation 1110-2-100 entitled "Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures."

This report presents the results of the third periodic inspection, instrumentation readings over the entire recording period, and remedial measures adopted by the District. As-built drawings showing significant project features are included in Appendix B. The appendix is intended to supplement the drawings presented in the second periodic inspection report for F. E. Walter Dam and will be referred to in future periodic inspection reports for specific as-built details of the project.

1-02. CONSTRUCTION HISTORY. The construction history of the dam site facilities was presented in the second periodic inspection report.

1-03. INSPECTION AND EVALUATION. As required by ER 1110-2-100 "Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures," a system of continuing evaluation including periodic inspection was planned to assure the safety and stability of the F. E. Walter Dam. These were intended to detect problem areas and provide a basis for recommendations of remedial treatment if and when required. Periodic inspections for Walter Dam have been performed or are tentatively scheduled in the following sequence:

Inspection	Time Interval	Scheduled Date	Actual Date
Initial	5 years	June 1966	7 Jun 1966
2nd Periodic	10 years	July 1971	20 Jul 1971
3rd Periodic	15 years	Sept 1976	10 Nov 1976
4th Periodic	19 years	July 1980	
5th Periodic	23 years	July 1984	

SECTION 2
THIRD PERIODIC INSPECTION

2-01. GENERAL. The third periodic inspection was held on 10 November 1976 and was attended by representatives of North Atlantic Division and Philadelphia District. The list of those attending is included in Appendix A. The pool level at the time of the inspections was elevation 1300.34 which is 50.34 feet above the intake channel invert elevation. Normal pool level is elevation 1300.

Upon arrival at the project site, the inspection party was briefed on the results of the previous periodic inspection. A review of the instrumentation data collected since the last inspection was made prior to beginning the inspection and a detailed check list was supplied for use during the inspections. The party inspected the intake tower, conduit, outlet channel slopes, downstream embankment contact, spillway walls and weir, access roads, recreation area, operations building and dam operator's residence.

Following the inspection, a critique was conducted in the project office based on the checklist which had been furnished. Comments made at the critique are summarized in the following subsections 2-02 through 2-09.

2-02. INSTRUMENTATION DATA. It is recommended that settlement pipe and piezometer readings be continued on their present schedule, one a year and monthly respectively, except the piezometers should be read when the pool rises 15 feet or more. For details of instrumentation results, refer to Section 4.

2-03. SERVICE BRIDGE.

a. Concrete Surfaces - No deficiencies noted

b. Concrete Cracks - No deficiencies noted.

c. Expansion Joints - Refer to separate report.

d. Drainage System - No deficiencies noted.

e. Structural Steel - Paint in good condition (Painted 1975)

f. Bearings - Refer to separate report.

g. Guard Rails and Fencing - No deficiencies noted.

h. Bridge Movement - Yearly surveys of expansion joint punch mark offsets, distance between punch marks, punch mark elevations, four corner elevations for top of both piers and tower platform and plumbness of Pier No. 2 along bridge alignment (relative to a fixed survey monument on pier cap) should be made.

2-04. INTAKE TOWER.

a. Structural.

(1) Concrete Surfaces - No deficiencies noted.

(2) Concrete Cracks - Cracking through the floor slab above the mezzanine floor and on downstream side of hatchway through slab to downstream wall of tower. Cracks noticed through penthouse roof slab at face of hatchway beam. Hairline crack showing rust stains noticed on east side of tower below elevation 1300.

Structural adequacy of concrete slabs is not affected by cracks noted above. Replacement of roof to prevent leakage through crack in roof slab is recommended.

(3) Leakage- Penthouse roof leaks around hatch due to freeze-up in drain line and deteriorated roofing. A new roof with lightweight concrete build-up to provide adequate drainage and possible relocation of drain to prevent freezing are needed.

b. Equipment.

(1) Service Gates and Hoists - Damper for air intakes on main gates needs replacing. Access to top of gates is a safety hazard. Recommend installation of catwalks to provide access to top of gates.

(2) Emergency Gates and Hoists - See comment above on access to service gates. Minor leakage around west side of gate noticed.

(3) Elevator - Fails to stop level with floors and does not stop at lowest level, but reverses and goes up at half speed. Service personnel have been notified about both items. Telephone operates sporadically and is undependable; Telephone company has been notified. Penthouse roof leaks on elevator controls.

(4) Sump Pumps and By-Pass Drain-Minor problems with controls due to corrosion. Installation of heaters in electrical controls to prevent condensation and resultant corrosion is recommended. Ice located in bottom of elevator shaft due to back up of water through drain to sump can be alleviated by relocating the sump pump intake to within one inch from the bottom of the sump.

(5) Electrical-Circuit breakers for the lowest floor level lights trip off frequently.

(6) Engine Generator - The gasoline storage tank is too large for long term storage since the fuel deteriorates and causes "varnish" deposits to clog the engine carburetor and water to accumulate in the storage tank. Since the furnace fuel tank is too small for the amount of heating oil used, use of the gasoline storage tank in tandem with the furnace fuel tank and installation of a new 25 gallon gasoline tank

(sufficient for 8 hours of operation) for the engine generator is recommended.

(7) Heating and Ventilating System - The furnace, as installed, is not performing the job intended; it appears to be too small, i.e. not enough BTU's at the bonnet. Replacement of the furnace with a new, higher capacity furnace or adding supplemental duct heaters at the lowest level is recommended. When the gates are open 8-10 feet, a vacuum is created within the tower and air is going out of the tower through the floor drains, causing the furnace chimney pipe to act as an air supply duct, in turn causing smoke from the furnace to fill the tower. By furnishing combustion supply air at the furnace and supply air to bottom level from the outside, the problem should be corrected. Heat from the furnace does not reach the lowest level of the tower. Extension of the hot air duct with the outlet as close to the lowest floor level as possible, installing a cold air return intake at elevation 1290, and the closing of intake at elevation 1270 is recommended.

2-05. TUNNEL.

a. Concrete Surfaces - Little change from last survey (1971).

b. Concrete Cracks - Little change from last survey (1971).

c. Leakage - Some exists, but is not considered serious.

d. Joints - No deficiencies noted.

2-06. OUTLET SLAB AND DISCHARGE CHANNEL.

Erosion of the 12 to 18-foot high right bank of the deep scour pool during periods of high discharge has oversteepened the right bank to the point of becomming a safety hazard. A cobble and boulder shoal has developed in the discharge channel downstream of the scour pool which backs up water into the tunnel and should be removed.

2-07. EMBANKMENT.

a. Surface Cracks - No deficiencies noted.

b. Abutment and Embankment Junctions - The lower one third of the left abutment contact was observed to be eroded into the abutment (10 feet wide by 5 to 6 feet deep) and should be repaired within the next few years. Also at this junction, minor seepage was noted below elevation 1330. This seepage may have neen related to the October pool levels. (el. 1360 and 1332 on 11 and 23 October 1976 respectively). The riprap toe along the downstream right abutment junction is sunken one or two feet over a distance of about 150 feet in the elevation 1400 vicinity probably due to the runoff erosion. Repair is not required at present.

c. Vertical and horizontal alignment - No deficiencies noted.

d. Unusual movement or cracking at or beyond toe - No deficiencies noted.

e. Unusual through embankment or downstream seepage - No deficiencies noted.

f. The 1976 survey of sixteen slope monuments installed in the downstream slope to monitor previously reported and surveyed irregularities (in the form of slight bulging of the lower slope portions) indicates continued creep movement subsequent to 1971. Similar irregularities of the upstream slope were noted to be definitely present in the inspection. The slow creep is not considered an impairment to embankment safety but does require development of an increased survey observation/instrumentation program as to the nature and cause of the creep. See paragraph 5 for subsequent action in this regard.

g. Movement of Structural features in Embankment (conduit and intake tower) - Check on plumbness of service bridge pier #2 to be made. This pier is founded in the embankment material.

2-08. SPILLWAY.

a. Concrete surfaces - Some minor spalling noted; no corrective action required.

b. Concrete cracks - Minor deficiencies, nothing of consequence.

c. Expansion joints - Some loss of sealant noted; no corrective action required.

d. Spillway side slopes - No deficiencies noted.

2-09. UPSTREAM RESERVOIR AREA.

a. Roadway surface - Pavement surface of road from operations building to LR 40041 is in poor condition. Resurfacing of its entire length should be scheduled for no later than the FY 1979 construction season.

b. Recreation Area - Cracking of stucco around top of block at well pumphouse noted. No corrective action required at this time.

c. Operations Building - Oil burner is obsolete and is apparently too small for enlarged building. Replacement of furnace with a new, larger and more efficient unit is recommended. Well water at drinking fountain has oil taste due to oil getting into old well during construction. Since the taste appears only at the drinking fountain, replacement of water pipe to the fountain and possible replacement of the water cooler are needed.

d. Dam tender's residence - Maintenance - repair items noted and furnished to Northern Area Engineer.

SECTION 3
CORRECTIVE MEASURES

3-01. GENERAL.

Several constructive measures have been undertaken by District personnel to alleviate problem areas. The inspection comments and actions taken are listed in subsection 3-02.

3-02. COMMENTS AND ACTIONS.

a. Bearings (on service bridge to intake tower) - During the summer of 1975, the rockers of both center span expansion bearings on pier No. 2, the pier closest to dam centerline, were observed to be misaligned longitudinally with their base plates and to be in a rotated position limiting span movement due to thermal contraction.

The situation was investigated on 29-30 September 1975 and a detailed report, entitled "Investigative Report - Misalignment of Expansion Bearings - Service Bridge", was prepared in September 1976 and concluded no remedial action was necessary but correction of problem should be done as funds become avialable. That report is included in Appendix D. In regard to slope irregularities discussed in Section 5, close visual inspection by members of the 1976 Periodic Inspection Team revealed no discernable slope irregularities in the vicinity of pier No. 2.

b. Structural details of ogee weir and gravity walls (in spillway)- "Western monolith of the tapered portion of the spillway gravity wall which joins the south spillway level has been displaced one inch horizontally towards the spillway chute at the lower construction joint".

A contract was let and completed in the summer of 1975 to jack and grout the monolith back into position. Repair considered satisfactory by third periodic inspection team.

c. Outlet works discharge channel - The deep scour pool noted in paragraph 2-06 developed shortly after the dam went into service. Rock and boulders were placed at the left bank prior to the first periodic inspection which to the present has prevented continuation of left bank erosion (towards the toe of the dam). Continued scour resulted in an oversteepened right bank and formation of a gravel, cobble and boulder shoal in the outlet channel downstream of the scour pool which were corrected prior to the second periodic inspection. As noted in this inspection the right bank and shoal problems have recurred and again require corrective work. It is expected that this work will be accomplished under normal operation and maintenance funding in FY 1977 or FY 1978.

SECTION 4
INSTRUMENTATION RESULTS

4-01. GENERAL. The results of readings for the period through July 1971 were presented in the second periodic inspection report and are also given in plates 1 to 5 of this report. A brief discussion of the instrumentation data for the period of July 1971 to the present follows.

4-02. PIEZOMETERS. The readings made since the piezometers were installed have remained relatively constant at normal pool elevations, varying with major fluctuations in pool level in a manner and at time lags considered normal for the structure and the locations of the instruments within the structure.

The piezometers in the upstream impervious core section located in the deep valley section of the dam (LWL-1 & LWL-6) generally show a reasonably quick (within 5 days) reaction to pool rises above normal pool elevation (El. 1300). LWL-12, also located in the upstream impervious core, reflects a similar reaction when the pool rises above the elevation of the piezometer tip (El. 1340±). These three piezometers indicated a normal phreatic level from 20 to 45 feet above normal pool and have shown a maximum increase of one third to one half the total increase in pool elevation. The latter was measured in June and July 1972.

The piezometers located in the core trench (LWL-3, LWL-8, and LWL-14) show small and relatively slow reactions to changes in pool level. Changes in the water levels at these locations normally occur five or more days later than the initial change in pool level and have been no greater than 6 feet since their installation in 1970.

Phreatic levels in the foundation downstream of the core trench are measured at piezometers LWL-5 in the right abutment, LWL-4, LWL-9, LWL-10 and LWL-11 in the deep valley section and LWL-15, LWL-16 and LWL-17 in the left abutment. LWL-15 and LWL-16 have remained dry since installation. The tip elevations of these piezometers (El. 1262 and El. 1258) are apparently above any phreatic surface yet measured in the left abutment foundation area downstream of the core trench. LWL-4, LWL-5, LWL-10, LWL-11 and LWL-17 all show rapid (2 to 3 day) reaction to major changes in pool elevation. These piezometers also appear to measure frequent changes in ground water level believed to be caused by local infiltration of rainfall which does not produce significant pool elevation change. Increases of as much as 10 feet have been noted in these piezometers following rises in pool elevation of 80 to 100 feet.

Piezometers LWL-18 and LWL-19 have continued to indicate no water since their installation in 1970. Piezometer LWL-20 has shown a fluctuating perched water table of 3.5±1 feet above the piezometer tip elevation of 1381.5 since 1971.

4-03. SURFACE SETTLEMENT MONUMENTS. Offset and elevation readings and corresponding changes for the surface settlement monuments on the crest and downstream slope are shown in Table 1. The crest monuments, all located along the upstream side of the crest, in general indicate small movements (3/4inch or less) in the upstream direction and 1/4 inch or less settlement in the valley portion. Changes for monuments located over the abutments are smaller and inconsistent.

For the reading period between 1971 and 1976 all monuments (steel rods) on the downstream slope indicate lateral movement in the downstream direction, the largest magnitude of 6 inches occuring 150 feet downstream with movements of up to 4.8 inches 300 feet downstream. The resultant of the lateral and vertical movements indicate apparent bulging of the slope at all but one (LWS-106) of the monuments.

During the 1976 survey the surveyors noted that at practically all of the slope monuments the outer casing and inner steel rod are in contact on the upslope side. According to the installation detail (4 inch diameter by $3\frac{1}{2}$ foot long casing, 1 inch by 6 foot rod - see Periodic Inspection Report No. 2) the contact seems to indicate that the creep is shallow surface movement rather than deeper deformation within the slope. This indication and the information available at this time is not sufficient, however, to establish which of the two types of movement has occured.

4-04. INTAKE TOWER AND BRIDGE PIER MOVEMENT. Monuments located on the tower platform and bridge piers were established following the first periodic inspection. Surveys of these points in 1966 and 1971 indicated no measurable settlement in that time period of the piers or tower and only negligible differential settlement between opposite or adjacent corners of the structures. Surveys of these points are to be repeated in the summer of 1977 in conjunction with other surveys scheduled at that time. Survey points to determine movement at the bridge were established on the expansion plates in 1976. A second survey will be done during the condition survey scheduled for the summer of 1977.

SECTION 5
SLOPE IRREGULARITIES

5-01. SUMMARY OF DATA AND OBSERVATIONS. Periodic Inspection Report No. 2 discusses irregularities of the downstream slope, surveys, and the instrumentation (16 surface settlement monuments and 3 high elevation piezometers) in that slope. In the November 1976 inspection, similar irregularities of the upstream slope were noted. The upstream slope irregularities were less evident at the time of the downstream instrumentation installation and were considered to be the result of normal construction tolerances. As previously noted in paragraphs 2-07f and 4-03, continued creep in the area of the downstream slope irregularities is shown by the instrumentation and similar creep is apparently occuring at the upstream slope. Data for the three piezometers is not sufficient to eliminate the presence of water as a contributing factor in the irregularities.

5-02. SUBSEQUENT ACTIONS. Subsequent to the October 1976 inspection, an auxiliary inspection with attendance by OCE was scheduled for May 1977 primarily in regard to the slope irregularities. A system of surface observation points was installed on the upstream slope in March 1977, the initial positions recorded at the same time, and an increased survey observation program established which will provide seasonal data with regard to possible relation of the creep to freeze-thaw action in the embankment material beneath the rock slope protection.

5-03. 4 MAY 1977 INSPECTION. Trip reports for this inspection are included in Appendix E. The embankment and slopes were inspected and as a result of the inspection early installation of inclinometers were added to the program to establish the depths at which the deformation is occurring.

5-04. ADDITIONAL INSTRUMENTATION - OBSERVATION PROGRAM.

a. Upstream Slope Observation Points. Three lines of points consisting of plugs set in or chiseled crosses on boulder size pieces of the upstream rock fill were installed and surveyed in March of 1977. A fourth line located lower on the slope which could not be installed at that time due to high pool levels will be installed during the scheduled surveys of the summer of 1977. The individual points were placed on boulders which were firmly lodged in the rock mass to reduce the possibility of independent movement of the point in relationship to the general movement.

b. Inclinometers. Two inclinometers, located at midslope height of the upstream and downstream slopes of the dam, will be installed in the late summer or fall of 1977. These inclinometers will provide information necessary to define the location of the zones of movement (if any) in those slopes.

c. Schedule of Observations. The upstream and downstream slope observation devices and the inclinometers are to be surveyed or read at least three times yearly. These readings will be made in early spring, midsummer and fall to determine the extend and rate of movement and possible connection with freeze-thaw action in the soil materials lying immediately beneath the rock fill.

SECTION 6
SUMMARY

The overall condition of the project is considered good. Instrumentation installed appears to be adequate except as noted herein with respect to the irregularities of the upstream and downstream slopes. Additional instrumentation is being installed to investigate this aspect. Minor remedial work will be accomplished by routine maintenance and as funds become available on the more significant items. It is expected that cutting back of the over-steepened outlet channel sideslope downstream of the tunnel outlet will be accomplished in 1977.

TABLE 1

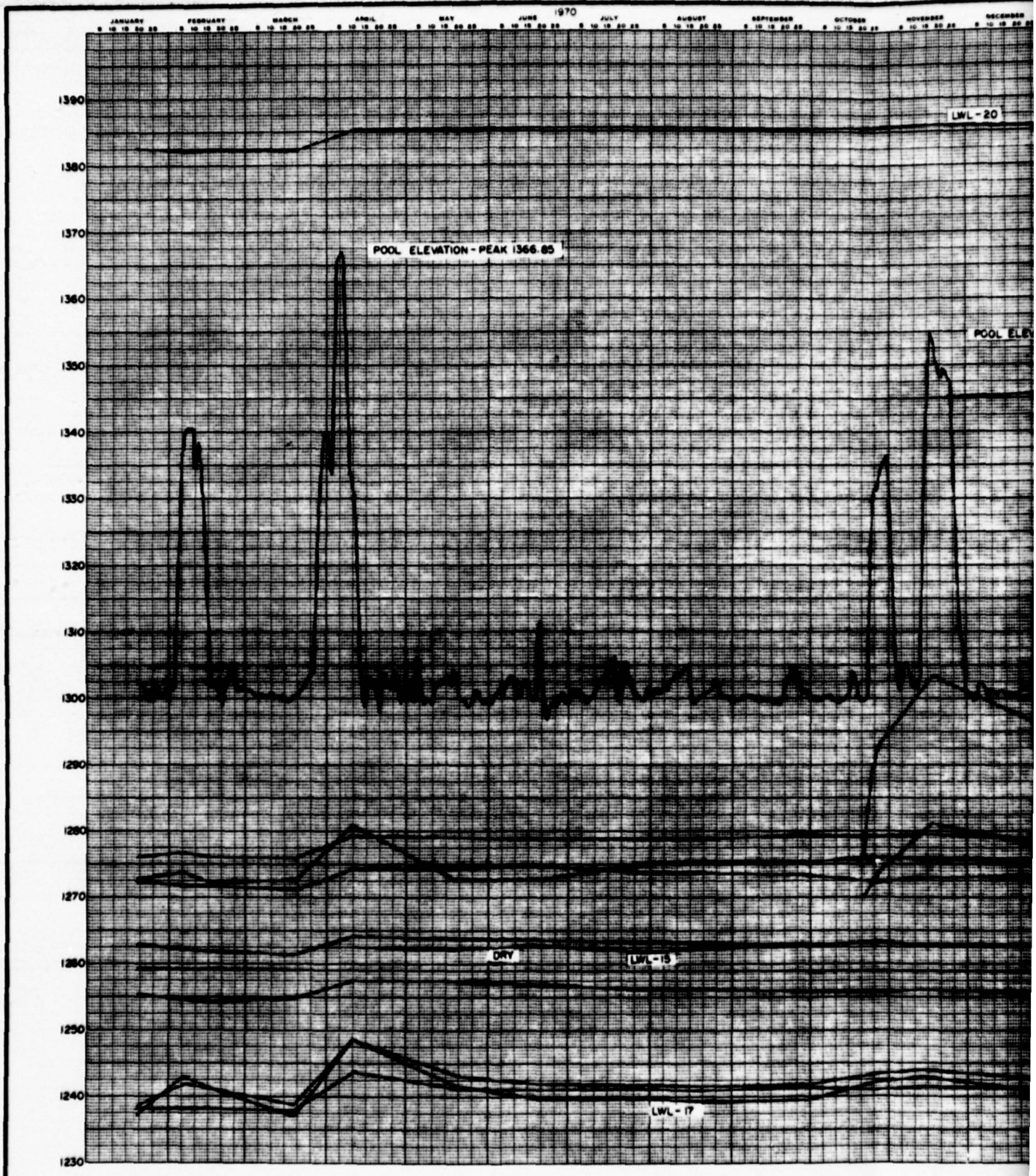
SURFACE SETTLEMENT MONUMENT READINGS

LOCATION	DESIGNATION	OFFSET FROM DAM ℄ 1971	OFFSET FROM DAM ℄ 1976	OFFSET* DIFFERENCE	ELEVATION 1971	ELEVATION 1976	ELEVATION ** DIFFERENCE
Crest-Line "A" 13' ± u.s. of dam ℄	LWS-1	13.34' u.s.	13.32' u.s.	-0.02	1473.91	1473.92	+0.01
	LWS-2	13.47' u.s.	13.53' u.s.	+0.06	1473.85	1473.86	+0.01
	LWS-3	13.37' u.s.	13.39' u.s.	+0.02	1473.55	1473.54	-0.01
	LWS-4	13.27' u.s.	13.27' u.s.	0	1473.97	1473.95	-0.02
	LWS-5	12.58' u.s.	12.63' u.s.	+0.05	1473.90	1473.88	-0.02
	LWS-6	13.39' u.s.	13.39' u.s.	0	1473.64	1473.64	0
Downstream Slope - Line "B" -150' ± d.s. of dam ℄	LWS-101	149.93' d.s.	150.22' d.s.	-0.29	1420.55	1420.59	+0.04
	LWS-102	146.59' d.s.	147.17' d.s.	-0.58	1419.82	1419.80	-0.02
	LWS-103	151,37' d.s.	151.90' d.s.	-0.53	1418.06	1418.35	+0.29
	LWS-104	149.97' d.s.	150.29' d.s.	-0.31	1419.59	1419.57	-0.02
Downstream Slope - Line "C" - 225' ± d.s. of dam ℄	LWS-105	222.69' d.s.	223.06' d.s.	-0.37	1394.10	1394.29	+0.19
	LWS-106	222.21' d.s.	222.24' d.s.	-0.03	1392.43	1392.40	-0.03
	LWS-107	222.51' d.s.	222.70' d.s.	-0.19	1390.15	1390.18	+0.03
	LWS-108	224.62' d.s.	224.75' d.s.	-0.13	1388.99	1389.06	+0.07
	LWS-109	224.14' d.s.	224.29' d.s.	-0.15	1388.51	1388.55	+0.04
	LWS-110	223.02' d.s.	223.22' d.s.	-0.20	1390.08	1390.07	-0.01
	LWS-111	224.49' d.s.	224.55' d.s.	-0.06	1388.88	1388.87	-0.01
Downstream Slope - Line "D" - 300' ± d.s. of dam ℄	LWS-112	300.49' d.s.	300.76' d.s.	-0.27	1362.44	1362.48	+0.04
	LWS-113	296.46' d.s.	296.80' d.s.	-0.34	1363.84	1363.87	+0.03
	LWS-114	298.31' d.s.	298.71' d.s.	-0.40	1361.90	1361.94	+0.04
	LWS-115	296.74' d.s.	296.82' d.s.	-0.08	1362.58	1362.57	-0.01
	LWS-116	296.97' d.s.	297.00' d.s.	-0.03	1362.76	1362.76	0
	LWS-117	300.87' d.s.	301.09' d.s.	-0.22	1361.78	1361.77	-0.01
	LWS-118	302.02' d.s.	302.09' d.s.	-0.07	1361.59	1361.67	+0.08

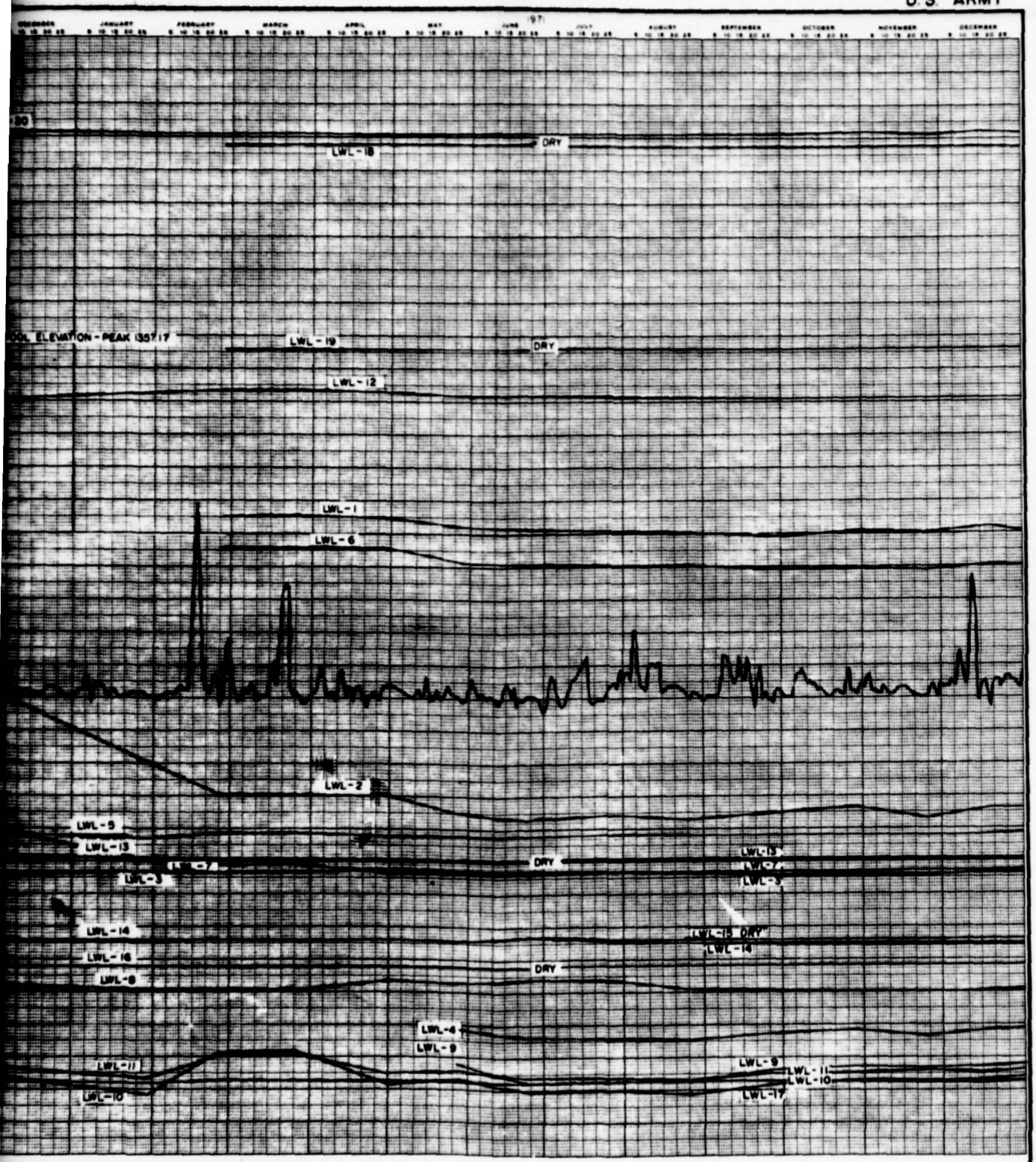
* (+) Upstream; (-) Downstream

** (+) Rebound; (-) Settlement

CORPS OF ENGINEERS



U.S. ARMY

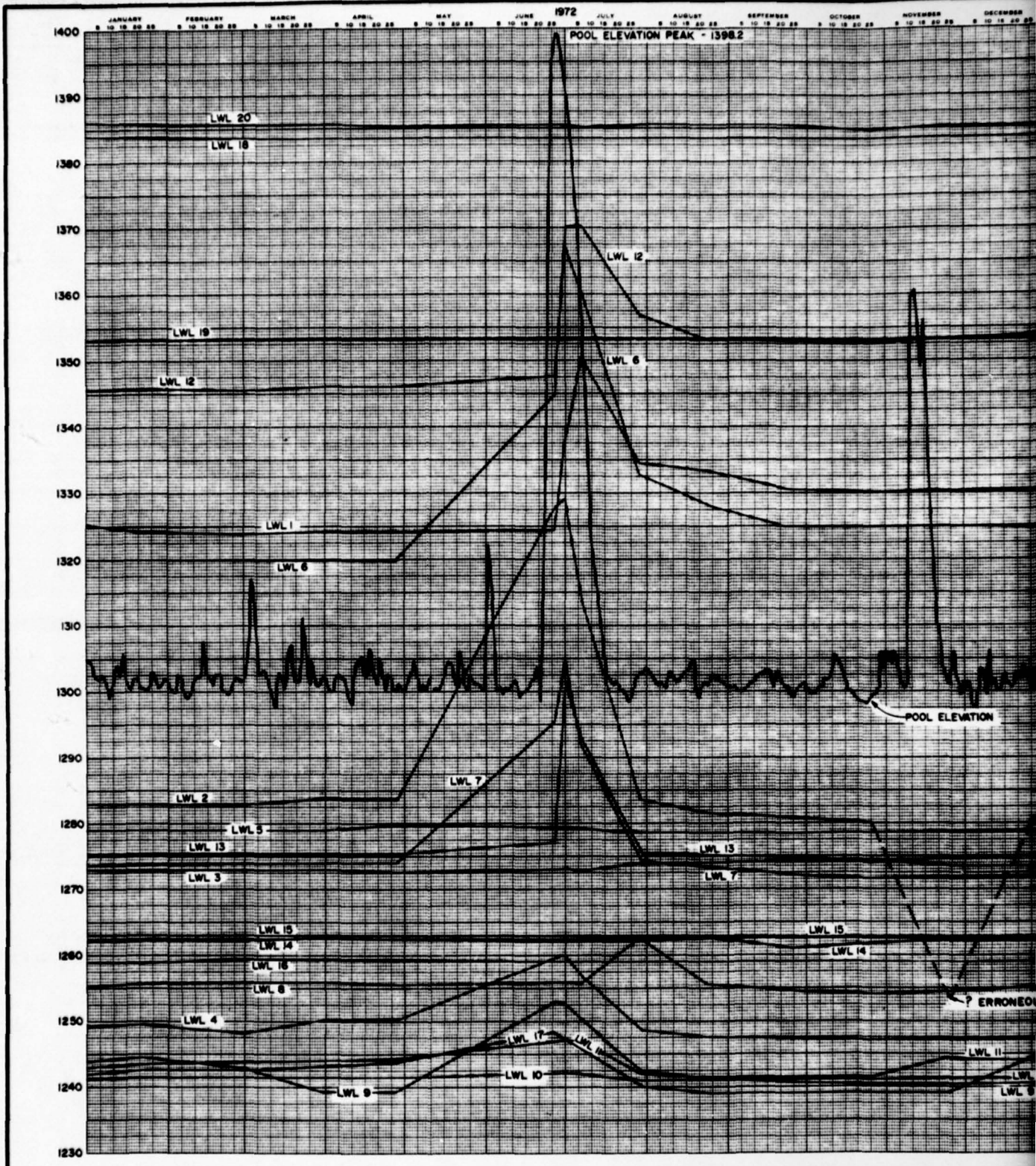


LEHIGH RIVER BASIN
FRANCIS E. WALTER DAM
LEHIGH RIVER PENNSYLVANIA

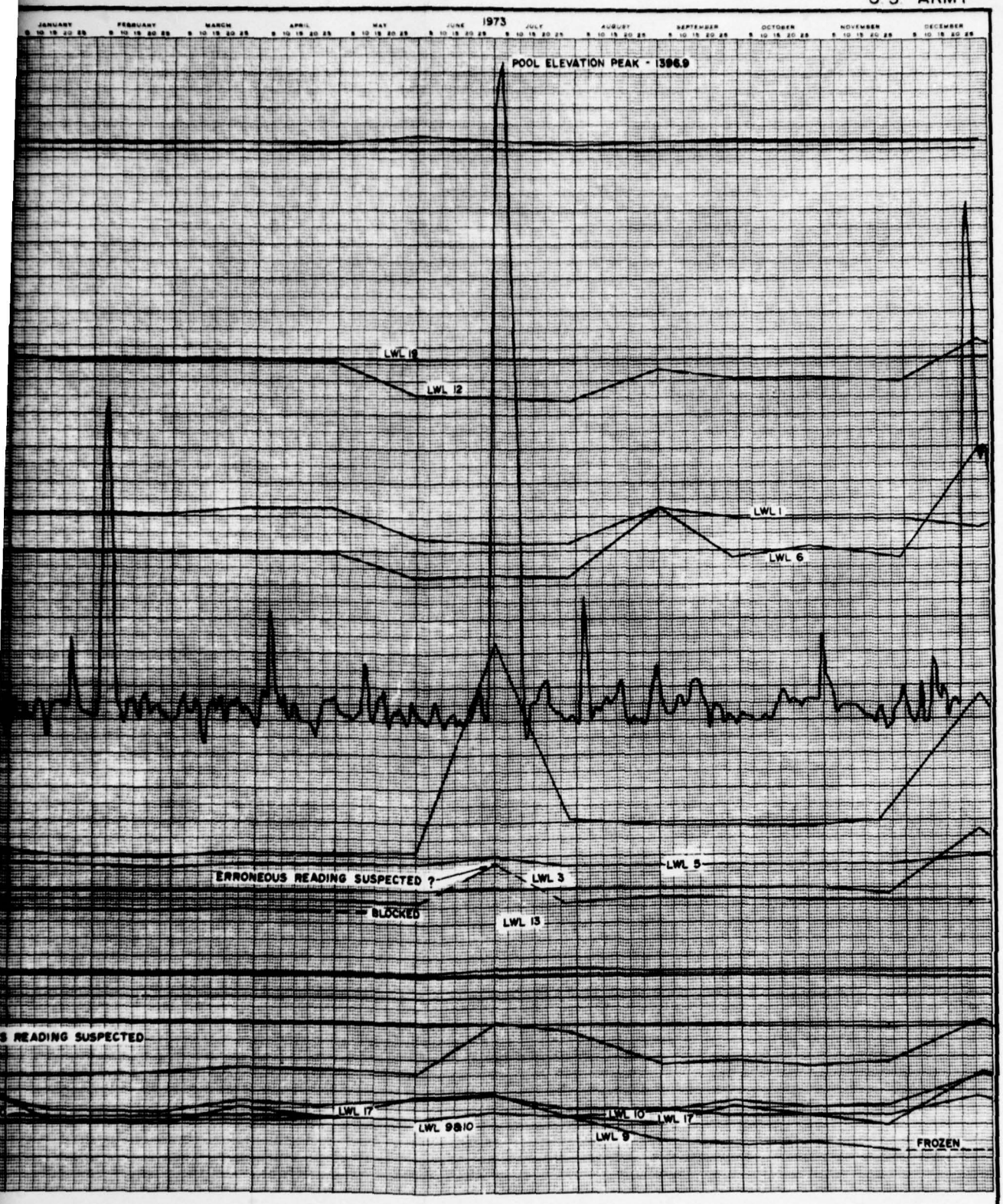
PIEZOMETER DATA
1970 - 1971

PLATE 1

CORPS OF ENGINEERS



U S ARMY



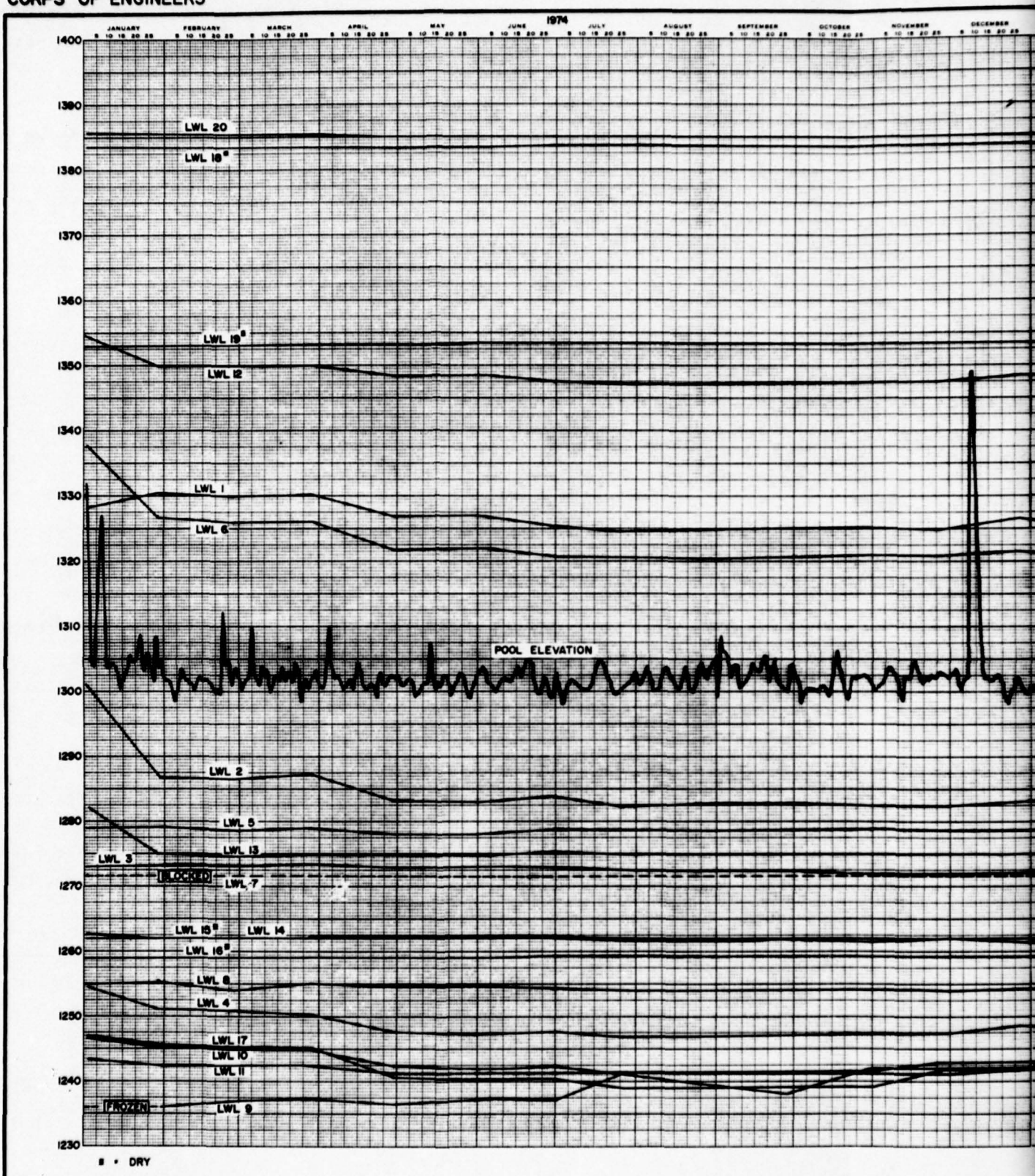
LEHIGH RIVER BASIN
FRANCIS E. WALTER DAM
LEHIGH RIVER PENNSYLVANIA

PIEZOMETER DATA
1972 - 1973

2

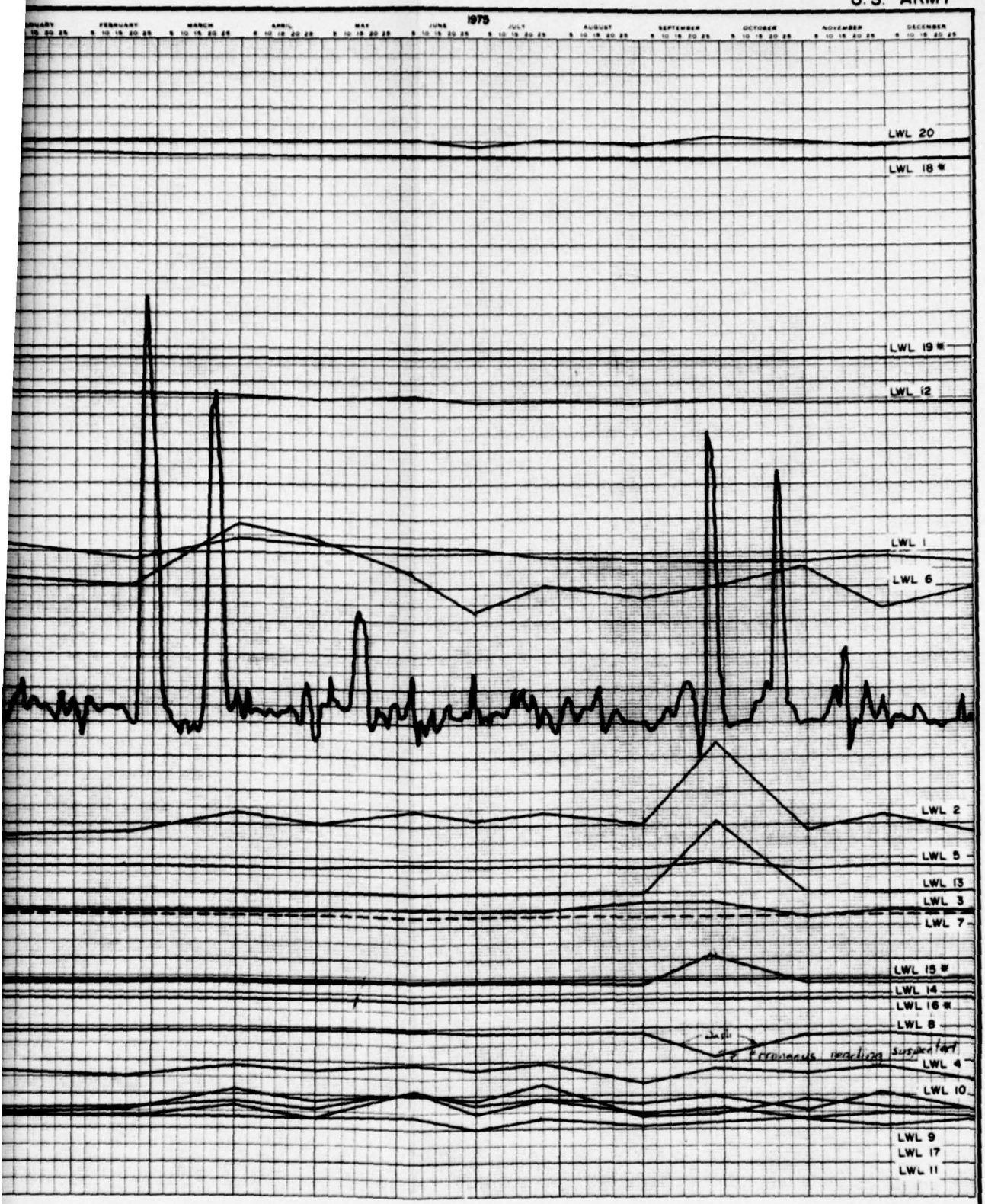
PLATE 2

CORPS OF ENGINEERS



* = DRY

U.S. ARMY

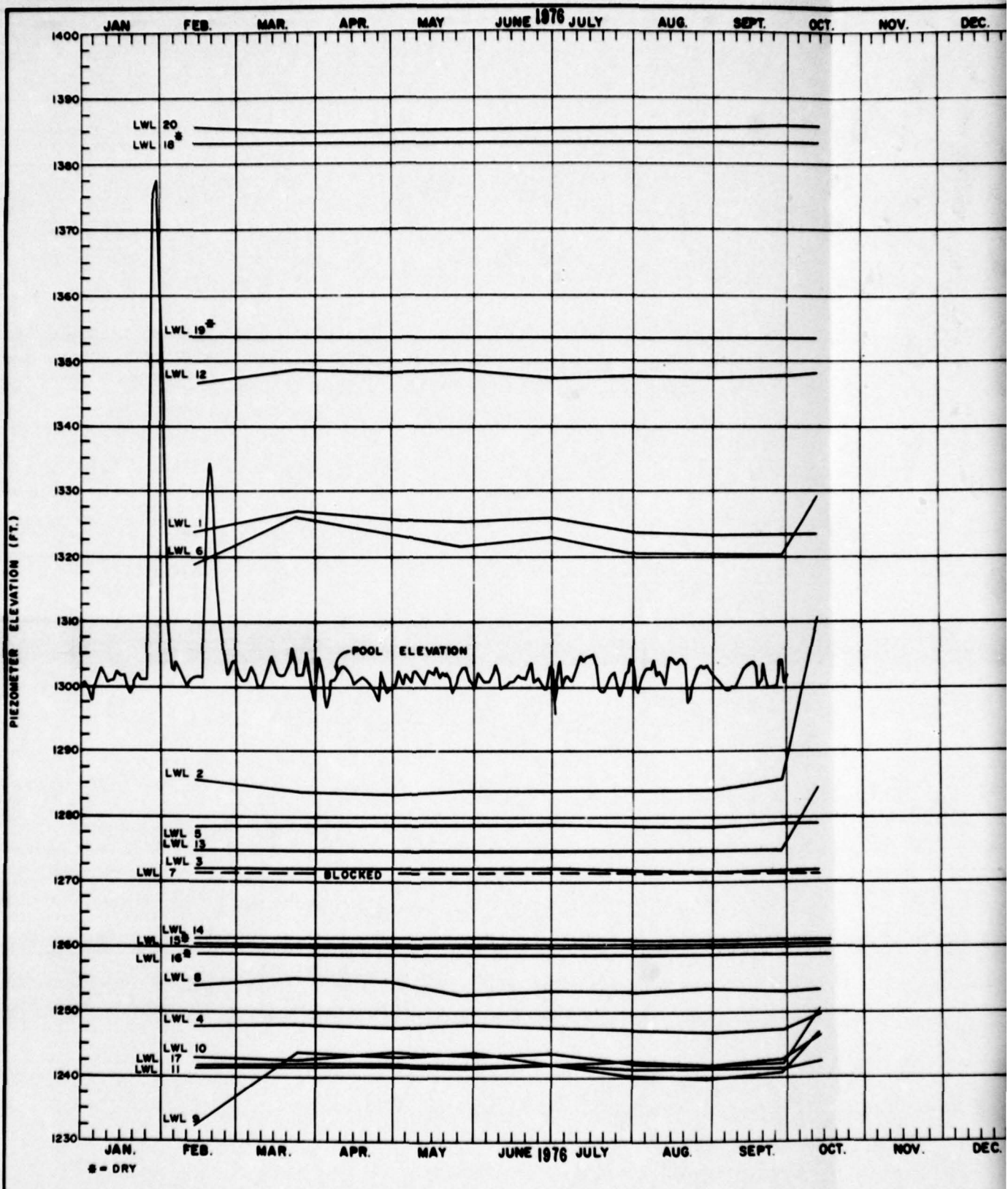


LEHIGH RIVER BASIN
FRANCIS E. WALTER DAM
LEHIGH RIVER PENNSYLVANIA

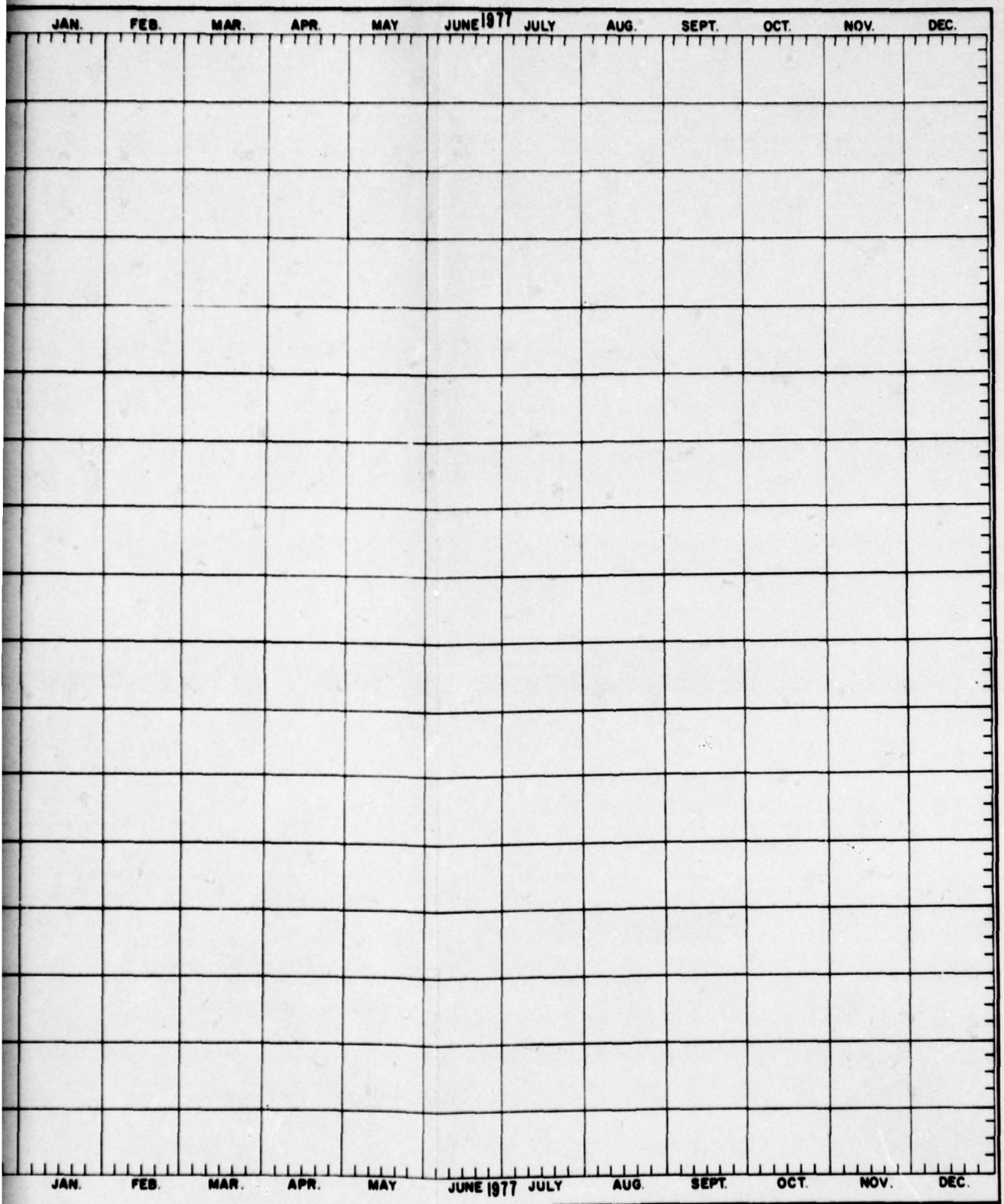
PIEZOMETER DATA
1974 - 1975

PLATE 3

CORPS OF ENGINEERS



U.S. ARMY



LEHIGH RIVER BASIN
FRANCIS E WALTER DAM
LEHIGH RIVER, PENNSYLVANIA

PIEZOMETER DATA
1976 - 1977

PLATE 4

APPENDIX A

CONDITION REPORT
FRANCIS E. WALTER DAM
LEHIGH RIVER, PENNSYLVANIA

DAM, OUTLET WORKS AND SPILLWAY

PERIODIC INSPECTION REPORT NO. 3

LIST OF ATTENDEES

F. E. WALTER DAM

List of Attendees - Periodic Inspection No. 3

G. Savage	NAD, Engineering Division
E. Eikstrems	NAD, Engineering Division
Major D. Means	NAO, Northern Area Engineer
R. Smith	NAO, Construction Representative
A. A. DePhilippe	NAP, Engineering Division
B. L. Uibel	NAP, Engineering Division
H. Rubright	NAP, Engineering Division
F. Braun	NAP, Engineering Division
E. Peterson	NAP, Engineering Division
S. Fritzinger	NAP, Engineering Division
F. A. Wildrick	Head Dam Operator
P. Stubbs, Jr.	Assistant Dam Operator

APPENDIX B

CONDITION REPORT
FRANCIS E. WALTER DAM
LEHIGH RIVER, PENNSYLVANIA

DAM, OUTLET WORKS AND SPILLWAY

PERIODIC INSPECTION REPORT NO. 3

NADEN-TF & TS REPORT OF PERIODIC INSPECTION NO. 3, FRANCIS E. WALTER DAM, DATED 7 DECEMBER 1976.

DAEN-CWE-SS TRIP REPORT - FRANCIS E. WALTER DAM, PA (PHILADELPHIA DISTRICT), DATED 11 MAY 1977.

NADEN-TF REPORT ON WALTER DAM, PA, DATED 12 MAY 1977.

DISPOSITION FORM

For use of this form, see AR 340-15; the proponent agency is The Adjutant General's Office.

REFERENCE OR OFFICE SYMBOL	SUBJECT
NADEN-TS	Periodic Inspection No. 3, Francis E. Walter Dam

XX MEMORANDUM FOR RECORD FROM Alvis I. Eikstrems DATE 7 Dec 76 CMT 1

Eikstrems/ez/7117

1. a. Date. 10 November 1976

b. Pool Level During Inspection. Conservation Pool

2. Description. Francis E. Walter Dam, formerly Bear Creek Dam, was completed in 1961. It is an earth fill dam with an impervious compacted earth core. Crest length is 3000 feet, width is 30 feet and the height above stream bed is 234 feet. The outlet works consist of a gate-controlled, concrete lined tunnel, 16 feet in diameter, 1,150.5 feet long. There are three sets of 5.66 feet x 10.0 feet gates operated from the intake tower. The spillway is a concrete ogee overflow section 4,200 feet long at the northwest end of the dam.

3. Problems

a. The intake tower access bridge center span expansion rockers on Pier No. 2, the pier closest to the coast of the dam, are misaligned longitudinally with their base plates, and are in a rotated position. This condition was discovered in the summer of 1975 and Philadelphia District has conducted a study to investigate the causes and the effect on the structure. The District has found no specific reason for the condition of the expansion rockers, and speculate that this may have been a construction misalignment, since file photographs indicate this condition existed already in 1965. Their analysis indicates that the position of the rockers will not introduce unacceptable stresses in the structure as a result of temperature changes. The District has instituted a system of measurements to monitor span movements.

b. Some new cracks were observed in the concrete floor at elevation 1290, around openings. This cracking does not presently affect the structural adequacy of the floor but should be monitored in future inspections.

c. The cracking of the concrete tunnel liner, while extensive, showed no significant progression from that charted during the previous inspection. Monitoring of the cracking should be continued in future inspections.

d. The side slope on the right side of the pool adjacent to the tunnel outlet has been eroded.

e. Irregularities were noted in the downstream slope protection. These irregularities in the form of slight bulging were noted in previous inspections and slope indicators were installed. These indicators show small continued movement. The slow creep is not considered to impair embankment safety, but monitoring should be continued.

f. Future corrective work may be required at an erosion gully forming where the downstream embankment meets the left abutment and for a minor subsidence. of stone protection toe where the downstream embankment meets the right abutment. No work is required at the present time.

g. Some leakage was noted through the intake tower joints in the bottom levels. The leakage, however, was not serious and has not progressed from that noted in the previous inspections. No action recommended.

4. Recommendations.

a. While the misalignment of the expansion rockers on the access bridge does not endanger the structure at present, a project should be initiated to correct this condition and allow the rockers to function normally.

b. The side slope of the pool adjacent to the tunnel outlet, which has been eroded, should be cut back for safety reasons.

Alwis I. Eikstrems

ALWIS I. EIKSTREMS
Civil Engineer

DISPOSITION FORM

For use of this form, see AR 340-15, the proponent agency is The Adjutant General's Office.

REFERENCE OR OFFICE SYMBOL	SUBJECT
DAEN-CWE-SS	Trip Report - Francis E Walter Dam, PA (Philadelphia District)

TO 1. DAEN-CWE
2. DAEN-CWZ-D
3. DAEN-CWZ-C
4. DAEN-CWZ-B
5. DAEN-CWZ-A
6. DAEN-CWE-S
7. DAEN-CWE-BB (File)

FROM DAEN-CWE-SS

DATE 11 May 1977

CMT 1

PARRETT/fm/36823

1. Date and Place: On 4 May 1977, the subject dam was inspected. The dam is across the Lehigh River below the confluence of Bear Creek in the Delaware River Basin.

2. Purpose: The purpose of the trip was to inspect the condition of embankment slopes and to evaluate the scope of the investigations being conducted.

3. Attendees: Bruce Uibel, Major Means, Floyd Wildrick - NAP, Tony Iarrobino - NAD, Neil Parrett - OCE.

4. Narrative: The dam began operation in December 1960. Irregularity in the embankment slope has been observed during the periodic inspections. Survey control of surface monuments installed to measure deformations began in 1971. Readings on these monuments were made in 1976. Movements have occurred, but not in a defined pattern. The frequency for reading surface monuments will be increased to two or three times yearly. No cracks in the surface have been observed. The bulge in the upstream slope remains at approximately the same elevation across the embankment, but decreases in effect with decreasing embankment height. The slope is 1V on 2.5H. The slope protection rock is 3 to 20 feet wide from top to bottom. The downstream slope appears to have depressions in the upper slopes and bulges at lower slopes. The slope is 1V on 2.5H. The right abutment area that experienced seepage during the high pool storage period of 1966 was inspected.

5. Conclusion: Engineers participating in this inspection concluded that slope movements are occurring and concur with the investigation work being performed.

6. Recommendations: Those participating in the inspection agreed to the following:

a. Slope indicators to rock should be installed at the mid-slope height of the upstream and downstream slope. The selection of locations should give consideration to overburden thickness and measured surface movements.

b. Evaluation information should include time plots of settlement, movement, pool level and piezometer data.

c. The report prepared for seepage experienced through the right abutment should be finalized and submitted to NAD for review.

NEP
PARRETT

CF:
Div Engr, NAD
Dist Engr, NAP
DAEN-CWO-C

DISPOSITION FORM

For use of this form, see AR 340-15, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL	SUBJECT
NADEN-TF	Walter Dam, PA

XX THRU Chief, Tech Engr Br
TO Chief, Engr Div

FROM Mr. A. V. Iarrobino

DATE 12 May 1977
Iarrobino/ez/7556

CMT 1

1. As a result of obvious depressions and bulges noted at the last periodic inspection in November 1976 in both the upstream and downstream slopes of the embankment, it was agreed that the district would monitor the situation over the winter and that a joint OCE-NAD-NAP on-site meeting would take place in May 1977. This meeting was held on 4 May and included the following:

Major Means	AE
F. Wildrick	Dam Tender
N. Parrett	OCE
B. Uibel	NAP
A. Iarrobino	NAD

2. The dam, an earth embankment with 1 on 2.5 slopes, completed in 1961, has a maximum height of 234' above stream bed; upstream and downstream slopes have 3' and 10 to 20' thick, respectively, dumped, uncompacted rock fill placed without bedding. The upstream semi-impervious zone was placed in 24" layers. The conservation pool is extremely shallow.

3. At the first periodic inspection in 1966 at which time the pool was 90' (1390) above conservation pool, seepage was noted at the right downstream groin. Water could be heard running beneath the riprap. Subsequently, as the pool was lowered to conservation level, it was reported that the seepage stopped when the reservoir level of 1343± was reached. At this time, the district undertook a study of this leakage. Also, it was reported that in December 1965, a 50' drawdown occurred within 36 hours. Reports indicate that there was no resulting damage or distress in the upstream slope. A subsequent total drawdown of 90' reportedly had no adverse effects upon the slope.

4. The second periodic report of the 1971 inspection states that settlement points along the crest, downstream slope and riprap show no evidence of past movements. However, the report states that irregularities were noted in the downstream slope, that the '66 and '69 surveys were inconclusive but seem to indicate a general settlement in the upper portion of the downstream slope with a corresponding bulge in the lower portion.

5. At this May 1977 meeting, the results of a comparison of the '76 survey of the downstream slope with the '71 survey were presented and clearly indicate that movement of the downstream slope is occurring. It was concurred in by all that the horizontal and vertical controls in both slopes currently being monitored by the district are adequate and monitoring should continue. However, in addition, at least one slope indicator should be placed in each slope to ascertain at what levels movements may be taking place. Additionally, continuous samples should be obtained and embankment shear strengths determined.

6. In addition to the above, it has been noted that previously three piezometers had been installed in the downstream slope to investigate the possibility of "perched" water. Piezometer #20 indicates water to be present in the embankment.

NADEN-TF 12 May 1977
SUBJECT: Walter Dam, PA

The possibility of water from rainfall and/or the abutments seeping into and through the embankment with a detrimental effect upon stability should be considered.

7. At this time, it has been concluded that movements in the downstream slope are occurring but the reason(s) are not known. Also, it is not clear as to whether the upstream slope was constructed to the currently existing grades or whether or not slope readjustments have taken place as a result of rapid drawdown and high impoundments of long duration (1966-1967) or as a result of other causes.

8. It is recommended that quarterly reports on the monitoring of the slopes be furnished this office. In addition, a report on the seepage at the right downstream groin at high impoundments and its potential consequences should be furnished without any further delay.

A. V. ZARROBINO

CF:
Mr. N. Parrett, OCE (DAEN-CWE-S)

Ch, Constr-Oper Div, NAD

APPENDIX C

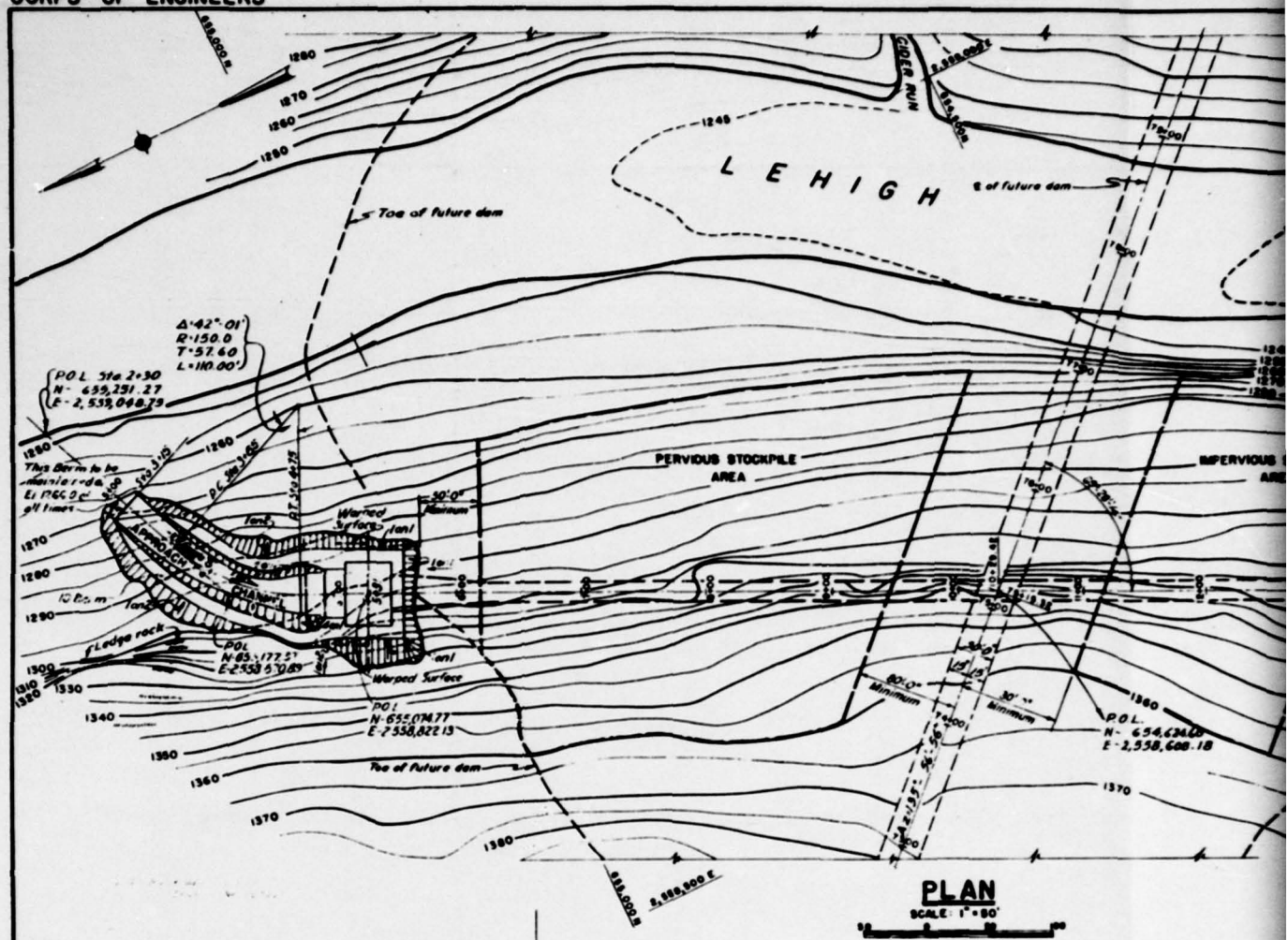
CONDITION REPORT
FRANCIS E. WALTER DAM
LEHIGH RIVER, PENNSYLVANIA

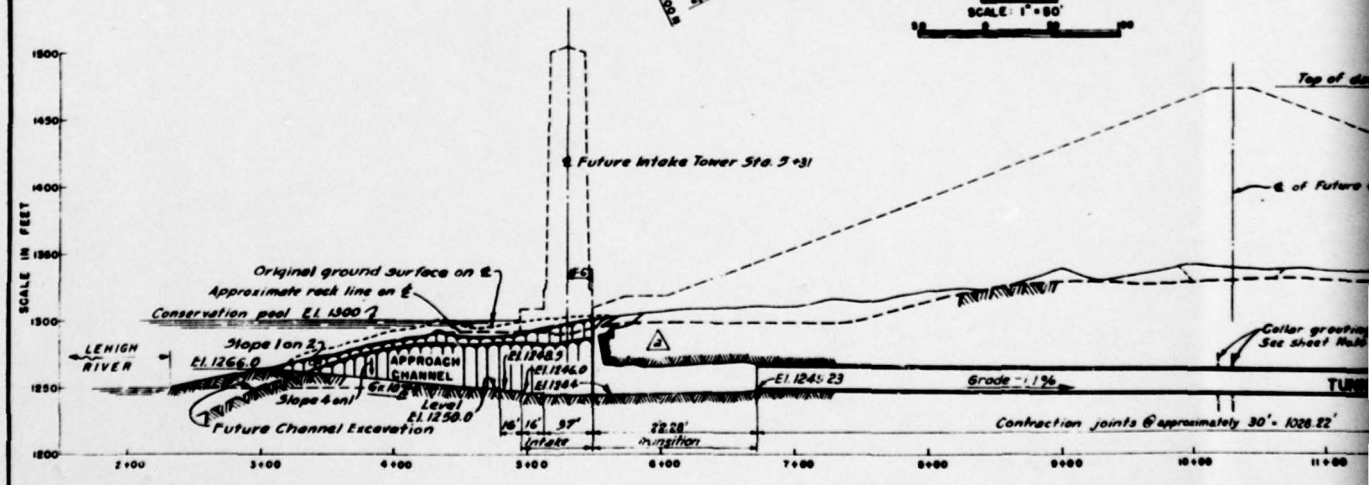
DAM, OUTLET WORKS AND SPILLWAY

PERIODIC INSPECTION REPORT NO. 3

SUPPLEMENTAL AS BUILT DRAWINGS

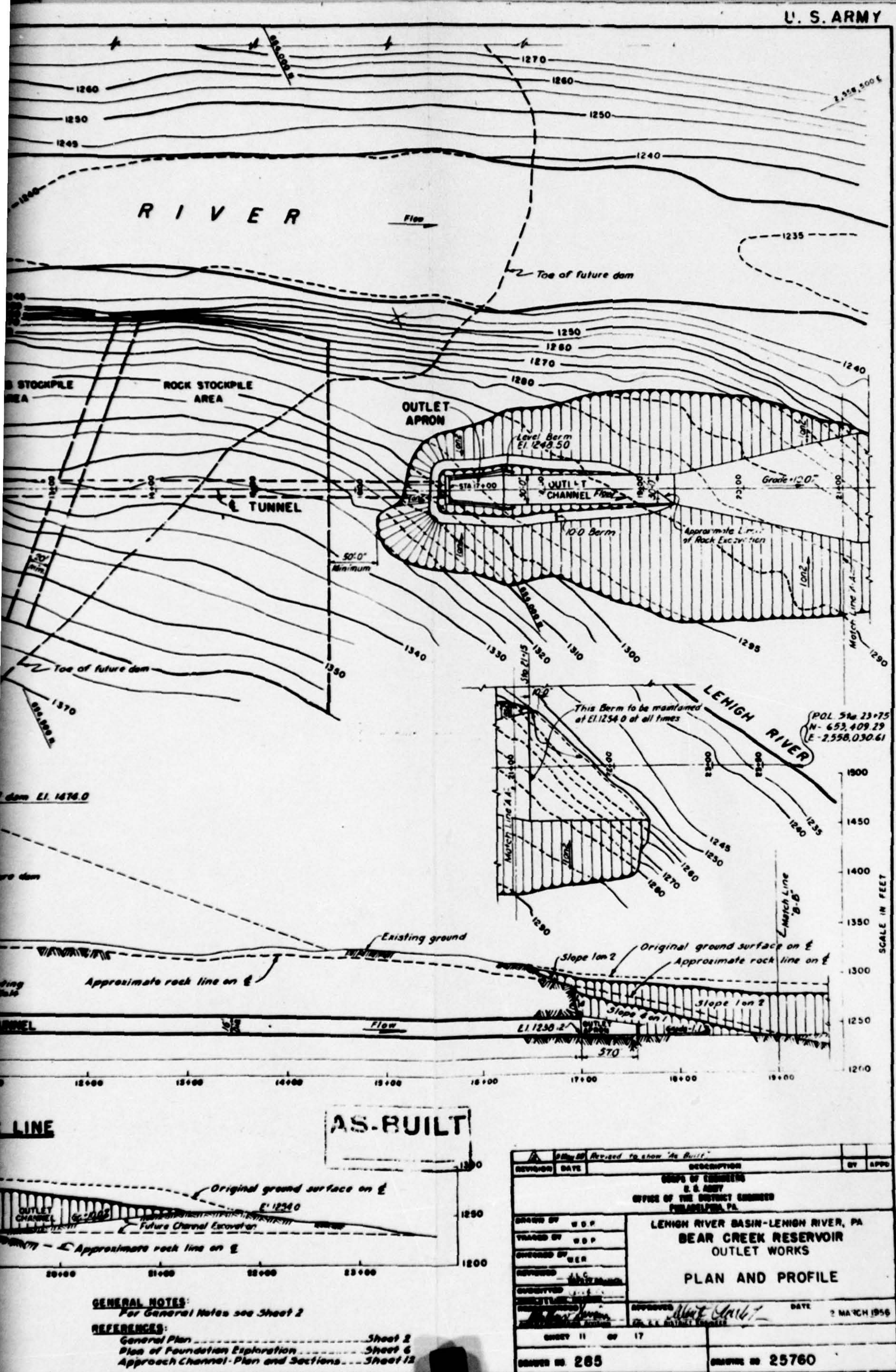
CORPS OF ENGINEERS

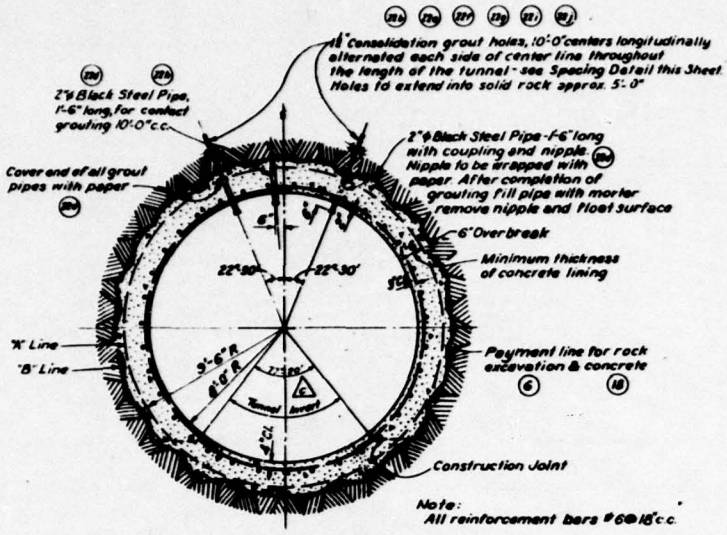




PROFILE ON CENTER
SCALE: 1"·80'

Match Line "B-B"


U. S. ARMY
RIVER
Flow
Toe of future dam
ROCK STOCKPILE AREA
OUTLET APRON
Level Berm El. 1248.50
OUTLET CHANNEL
Grade +12.0%
TUNNEL
10.0 Berm
Approximate Limit of Rock Excavation
50.0' Minimum
LEHIGH RIVER
This Berm to be maintained at El. 1254.0 at all times
P.O.L. Sta. 23+75
N - 653,409.29
E - 2,558,030.61
Match Line "A-A"
Match Line "B-B"
Existing ground
Original ground surface on ℄
Approximate rock line on ℄
Slope 1 on 2
El. 1238.2
570
SCALE IN FEET
AS-BUILT
Future Channel Excavation
Revised to show "As Built"
REVISION
DATE
DESCRIPTION
BY
APPD
CORPS OF ENGINEERS
U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
PHILADELPHIA, PA.
LEHIGH RIVER BASIN-LEHIGH RIVER, PA
BEAR CREEK RESERVOIR
OUTLET WORKS
PLAN AND PROFILE
DRAWN BY W.D.P.
TRACED BY W.D.P.
CHECKED BY W.E.R.
APPROVED
DATE
2 MARCH 1956
SHEET 11 OF 17
DRAWER NO. 285
DRAWING NO. 25760
GENERAL NOTES:
For General Notes see Sheet 2
REFERENCES:
General Plan .... Sheet 2
Plan of Foundation Exploration .... Sheet 6
Approach Channel - Plan and Sections .... Sheet 12



TYPICAL TUNNEL SECTION

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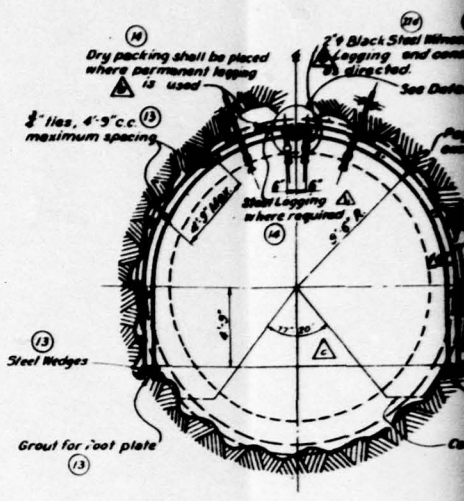
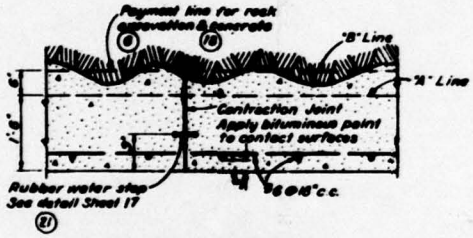


TUNNEL SECTION STEEL SUPPORTS

SCALE: 1/8 IN. = 1 FT.



TYPICAL TUNNEL CONTRACTION JOINT

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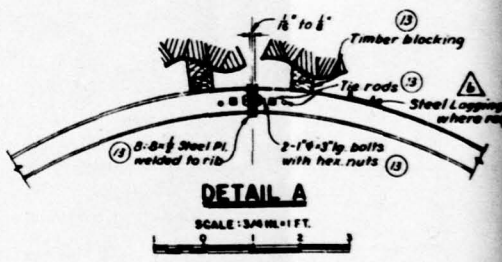
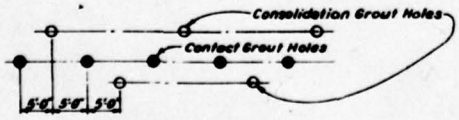


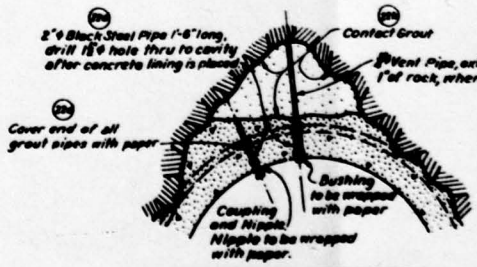
DETAIL A

SCALE: 3/4 IN. = 1 FT.



SPACING DETAIL TYPICAL TUNNEL GROUTING

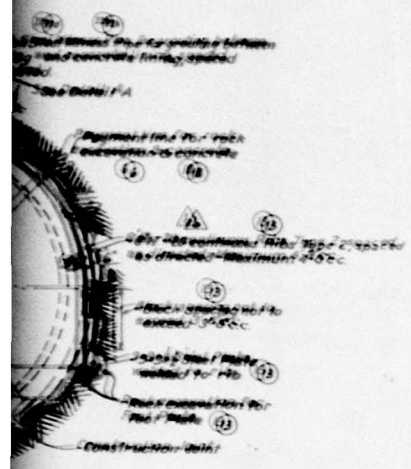
NOT TO SCALE

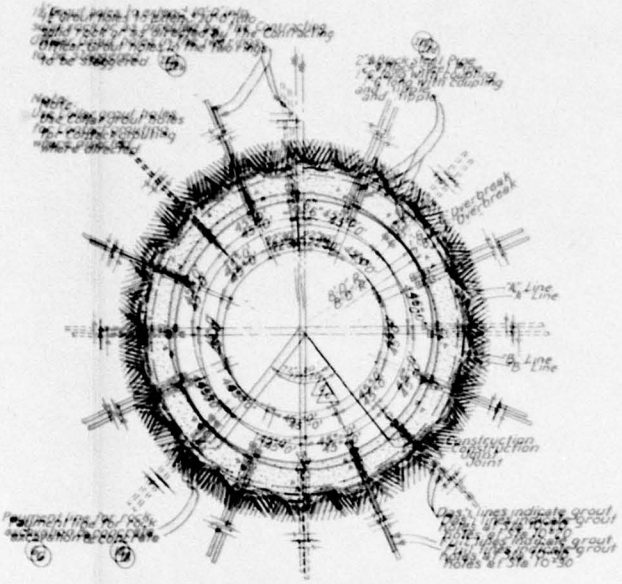


EXCESSIVE OVERBREAK CONTACT GROUTING DETAIL

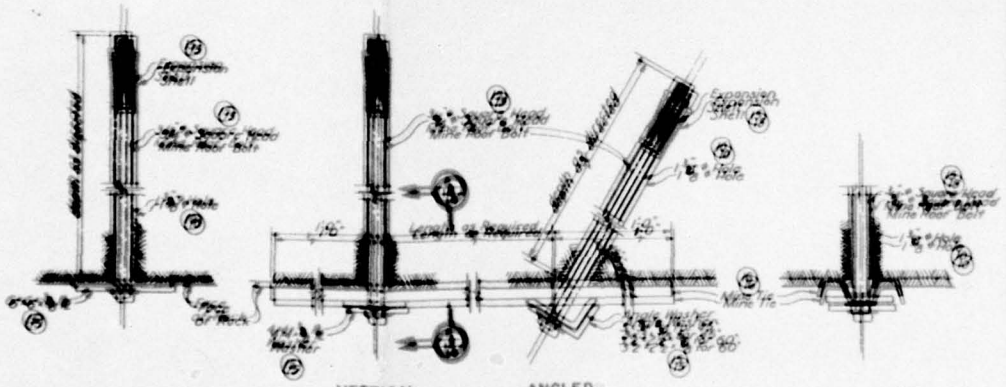
SCALE: 1/4 IN. = 1 FT.

U. S. ARMY





TUNNEL SECTION
COLLAR GROUTING



WITH PLATE

VERTICAL ANGLED
WITH NUT TIE

SECTION

ROCK BOLT DETAILS

AS-BUILT

GENERAL NOTES.

All exposed formed concrete surfaces shall have a Class "B" Finish

All exposed unformed surfaces of concrete shall be screed finished machine finished which shall be steel trowel finished

All exposed edges of concrete shall be chamfered 3/4" or as directed by the Contracting Officer.

Reinforcement shall be placed with a minimum protective cover of 3 inches otherwise shown or as directed

For additional General Notes see Sheets 2 and 12

REFERENCES.

Plan and Profile
Tunnel Transition Excavation - Plan and Sections
Tunnel Outlet and Outlet Sections

REVISION	DATE

OFFICE OF THE DISTRICT ENGINEER

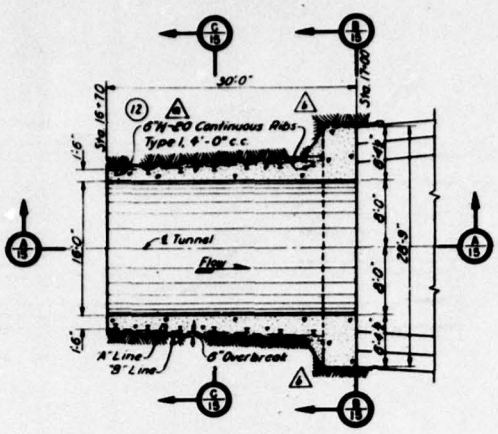
LEHIGH RIVER BASIN - LEHIGH RIVER, PA

BEAR CREEK RESERVOIR
OUTLET WORKS

TUNNEL SECTIONS AND DETAILS

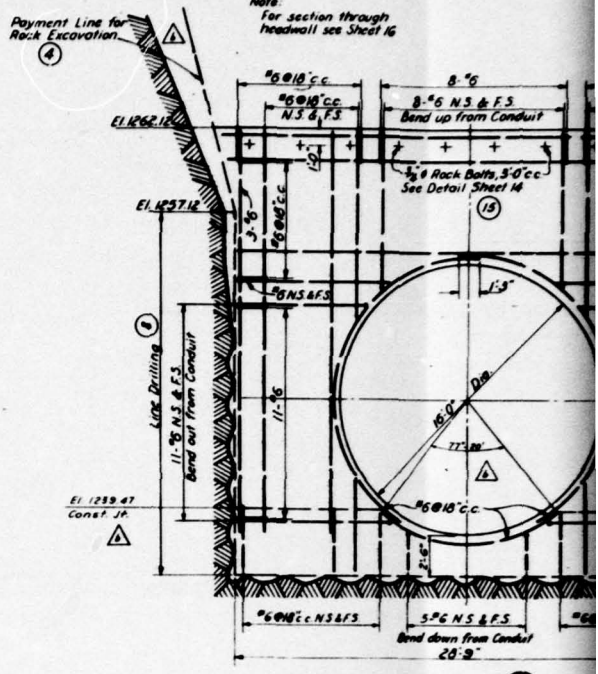
DRAWING NO. 285

CONTRACT NO. 25783



SECTIONAL PLAN

SCALE: 1/8 IN. = 1 FT.



SECTION

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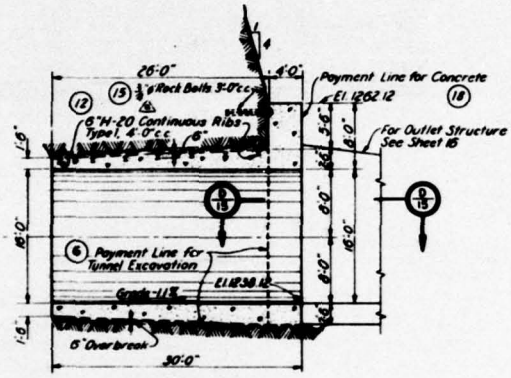

SECTION

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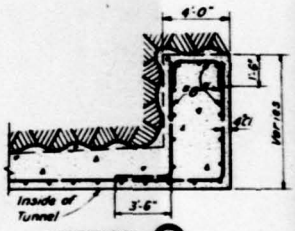
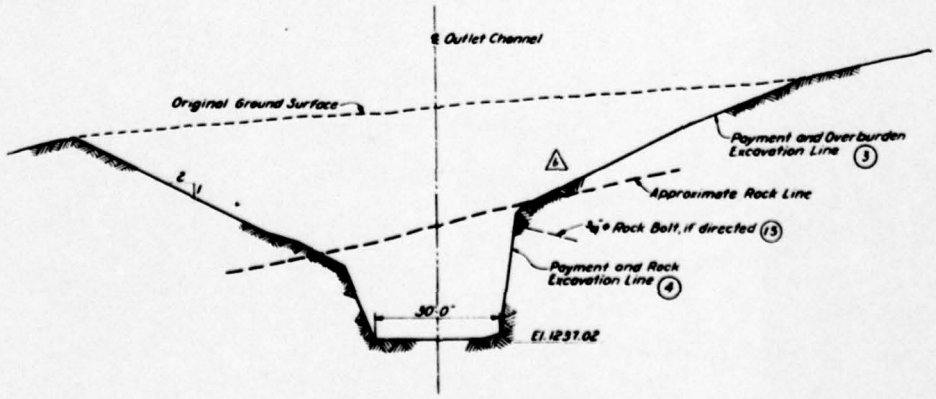
0 4 8 12 16 20



SECTION

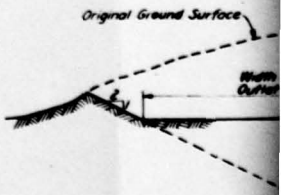
SCALE: 1/4 IN. = 1 FT.



SECTION AT STA. 18+00

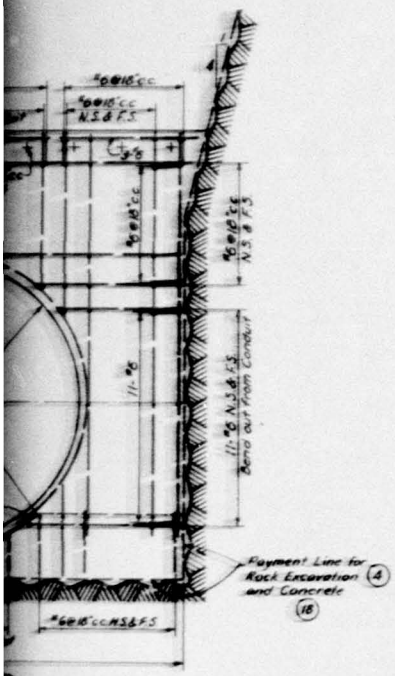
SCALE: 1/16 IN. = 1 FT.

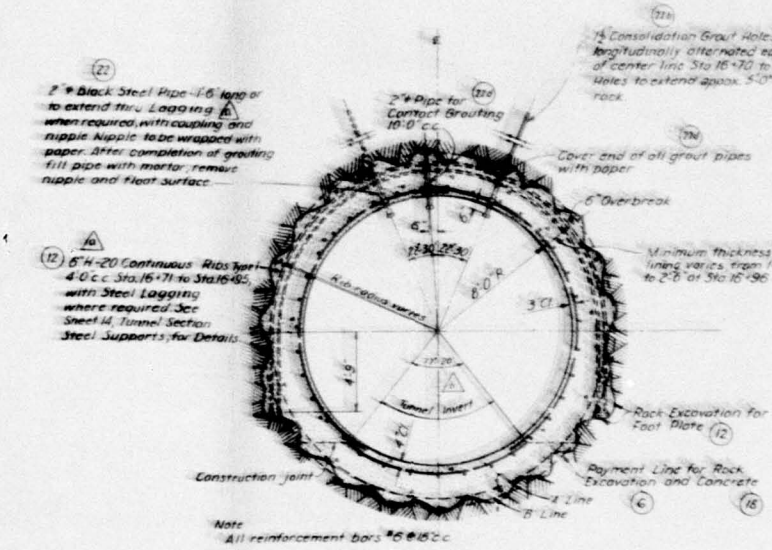
16 0 16 32



SECT

U. S. ARMY





SECTION (6/18)

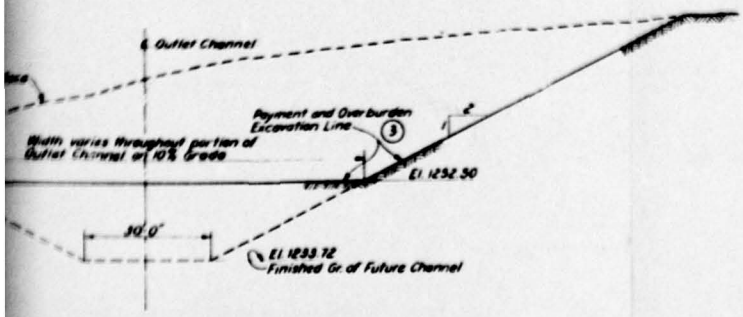
SCALE 1/4"N = 1'FT

GENERAL NOTES

For General Notes see Sheets 2, 12, and 14

REFERENCES

Plan and Profile	Sheet 11
Tunnel Sections and Details	Sheet 14
Outlet Structure - Plan and Sections	Sheet 16



SECTION AT STA. 21+00

SCALE 1/16"= 1'FT

REVISION	DATE	DESCRIPTION	BY	APPD
(A)	30 Apr 56	Revised to show 36" Steel Lagging in Liner Plates.		

CORPS OF ENGINEERS
U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
PHILADELPHIA, PA.

DRAWN BY: C.A.A.
TRACED BY: H.L.
CHECKED BY: A.A.K.
REVIEWED: [illegible]
SUBMITTED: CHIEF, DESIGN BRANCH
APPROVED: [illegible] CHIEF, ENGINEERING DIVISION
APPROVED: [illegible] DIST. ENGR.
DATE: 2 MARCH 1956

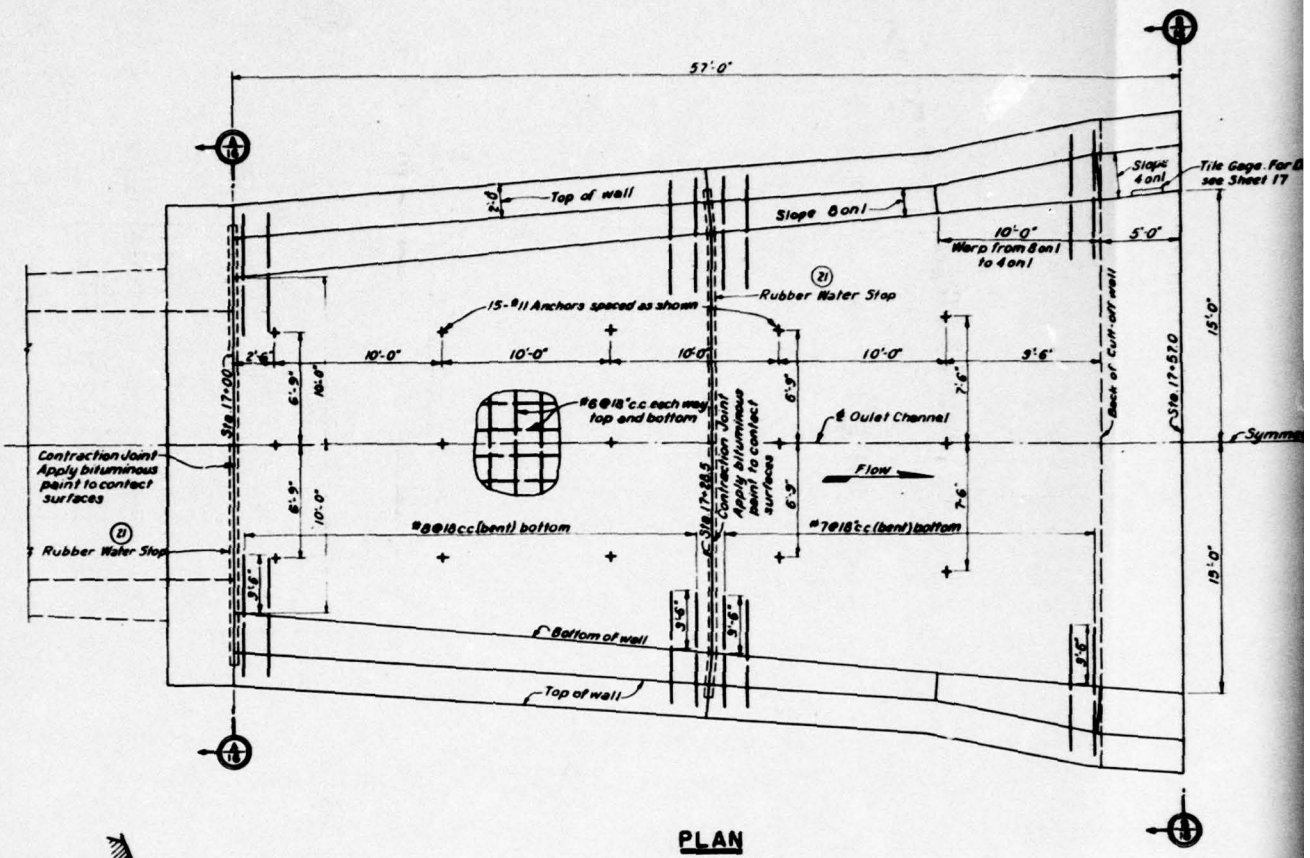
LEHIGH RIVER BASIN - LEHIGH RIVER, PA.
BEAR CREEK RESERVOIR
OUTLET WORKS
TUNNEL OUTLET
AND OUTLET SECTIONS

SHEET 15 OF 17

CONTRACT NO. 285
DRAWING NO. 25764

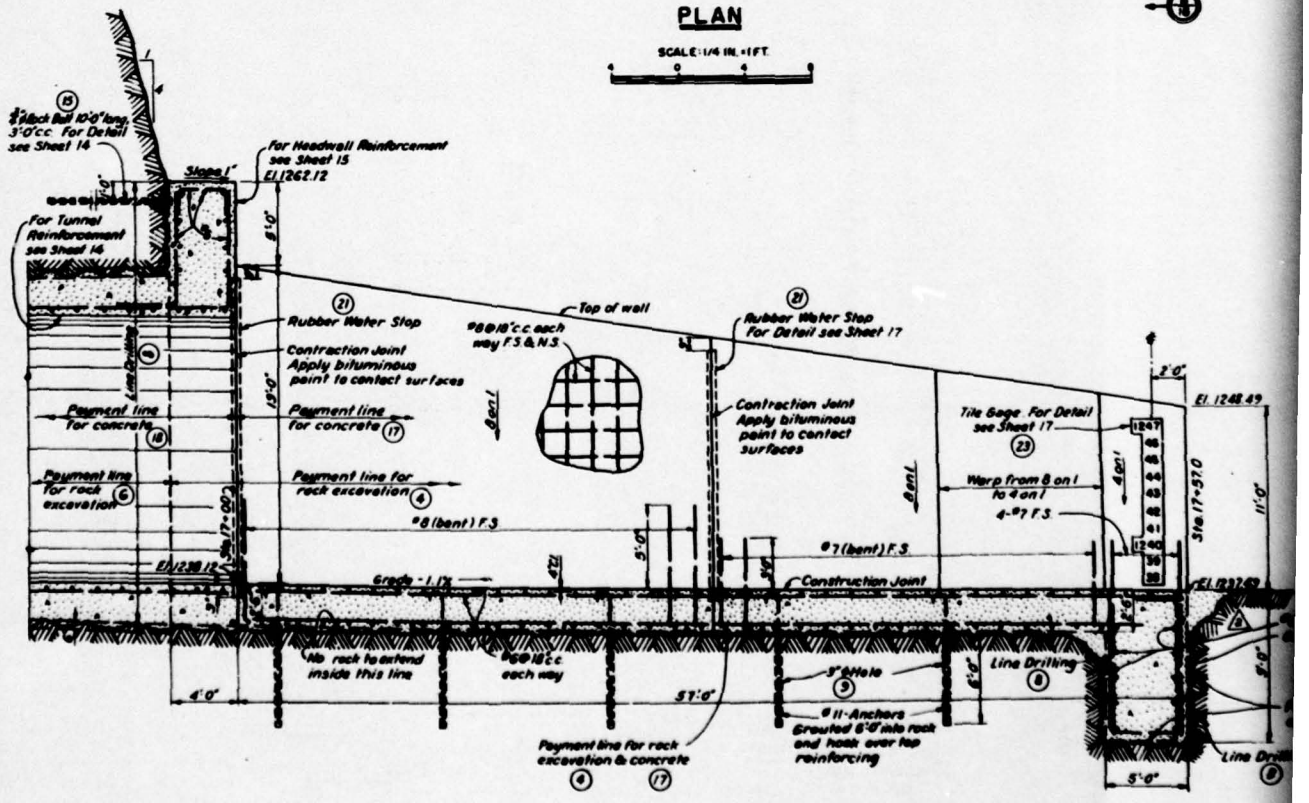
(15)

CORPS OF ENGINEERS



PLAN

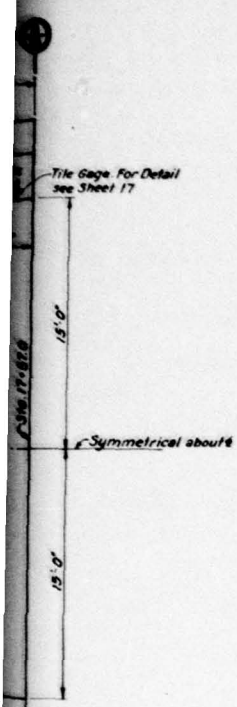
SCALE: 1/4 IN. = 1 FT.

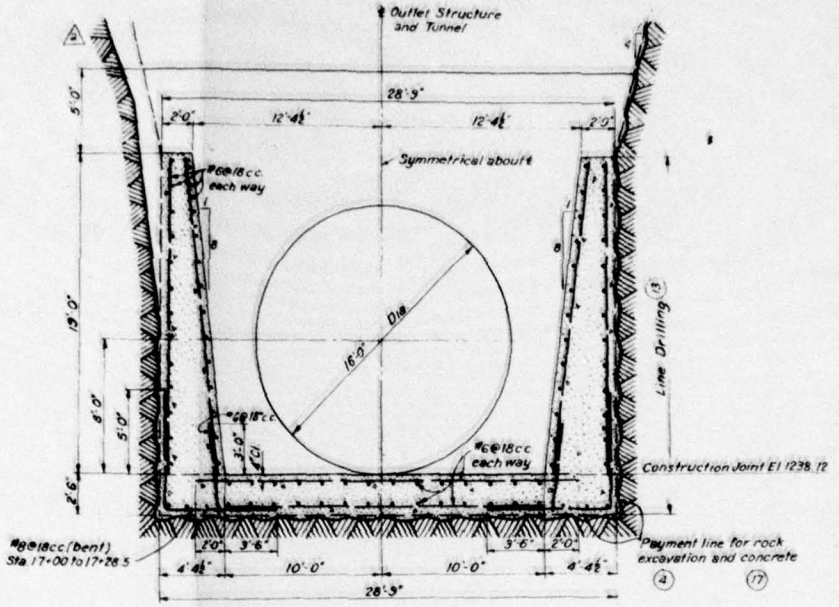


LONGITUDINAL SECTION ON CENTER LINE

SCALE: 1/4 IN. = 1 FT.

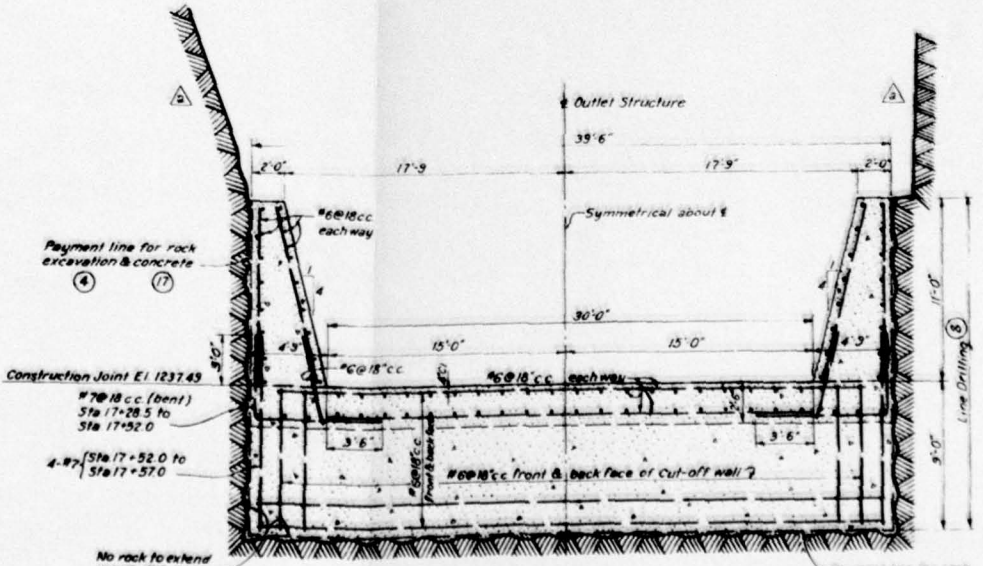
U. S. ARMY





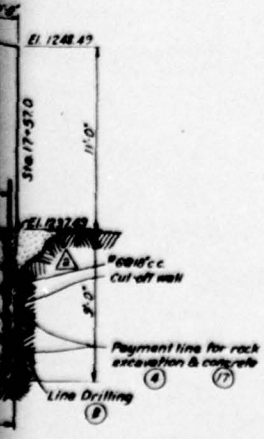
SECTION A

SCALE: 1/4 IN. = 1 FT.



SECTION A

SCALE 1/4 IN. = 1 FT.



GENERAL NOTES

For General Notes see Sheets 2, 12 and 14.

REFERENCES

General Plan	Sheet 2
Plan and Profile	Sheet 11
Tunnel Outlet and Outlet Sections	Sheet 15
Miscellaneous Details	Sheet 17

REVISION	DATE	DESCRIPTION	BY	APPD
2	6 May 58	Revised to show "A" (to 17)		

CORPS OF ENGINEERS
U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
PHILADELPHIA, PA.

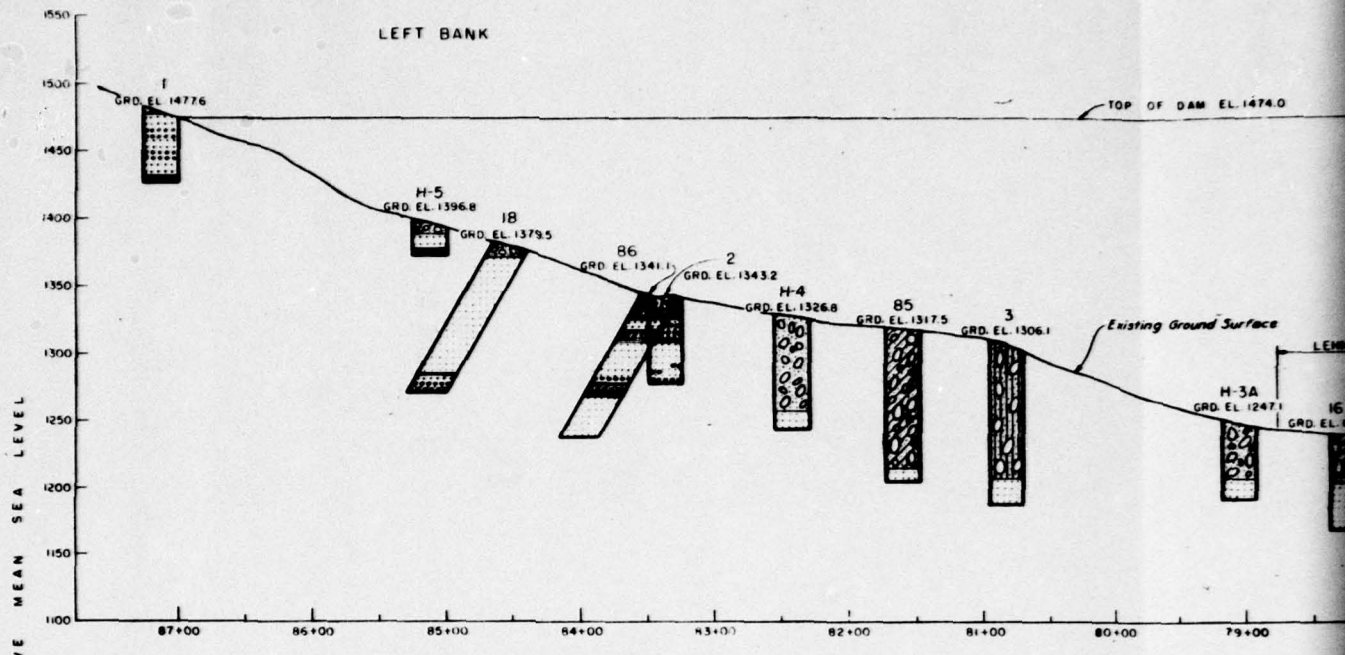
DRAWN BY E.P.
TRACED BY S.K.
CHECKED BY A.A.K.
REVIEWED
SUBMITTED
RECOMMENDED
APPROVED — DATE 2 MARCH 1956

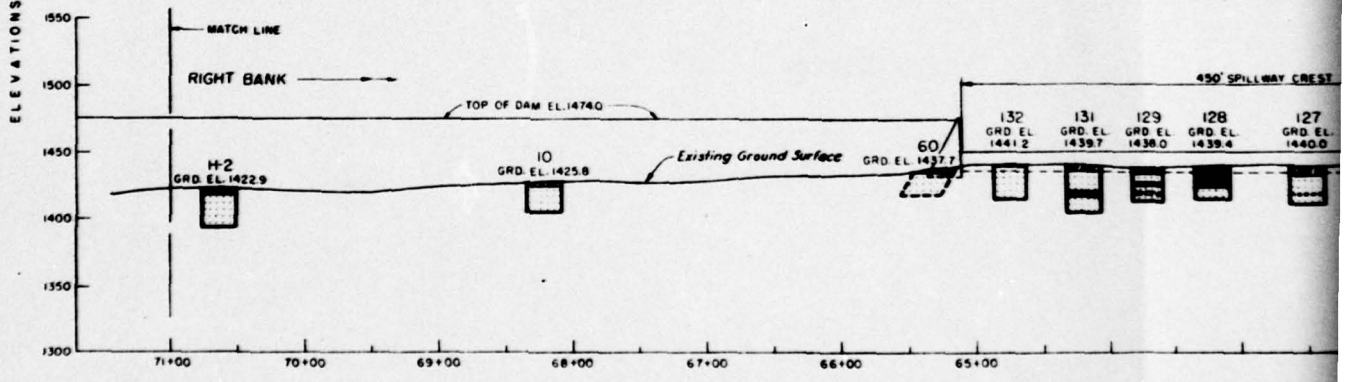
LEHIGH RIVER BASIN - LEHIGH RIVER, PA.
BEAR CREEK RESERVOIR
OUTLET WORKS
OUTLET STRUCTURE
PLAN AND SECTIONS

SHEET 18 OF 17

DRAWER NO. 285 DRAWING NO. 25765

CORPS OF ENGINEERS





GEOLOGIC SECTION ALONG
AND SPILLWAY

SCALE 1 IN. = 50 FT.
50 0 50

LEGEND

OVERBURDEN

SAND | SILT | CLAY | GRAVEL | COBBLES & BOULDERS

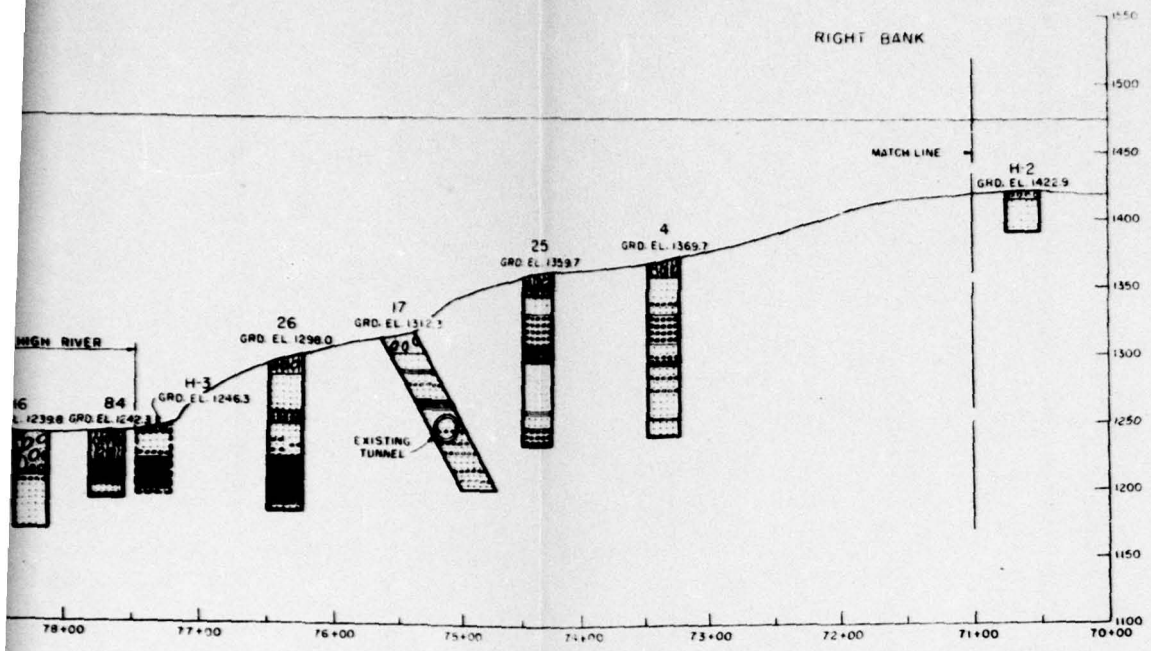
ROCK

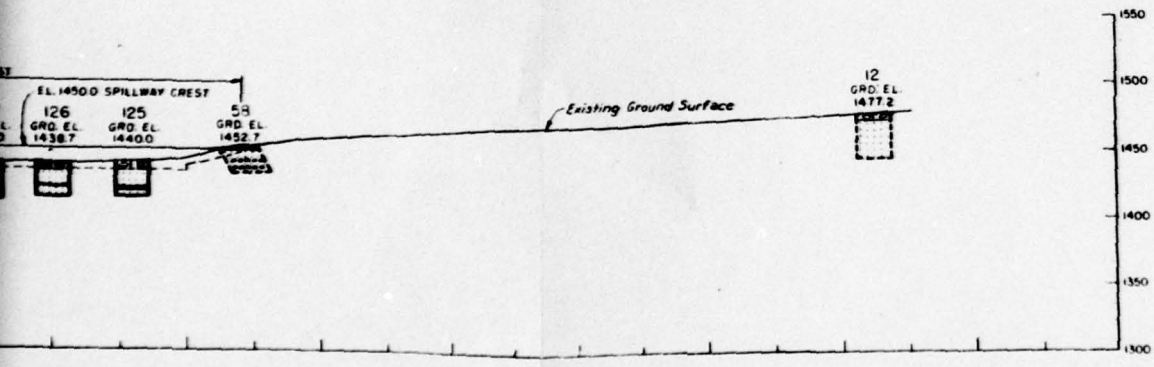
SANDSTONE | SHALE OR SILTSTONE | QUARTZ CONGLOMERATE

Denotes Borings on axis of Dam and Spillway

Denotes Borings projected on axis of Dam and Spillway

U. S. ARMY





AXIS OF DAM

AS-BUILT

GENERAL NOTES

Geologic Section is taken looking downstream.
For additional General Notes see Sheet 2 (etc.)

REFERENCES

Plan of Foundation Exploration ----- Sheet 7
Record of Foundation Exploration --- Sheets 8 to 16 incl.

REVISION	DATE	DESCRIPTION	BY	APPD.

CORPS OF ENGINEERS
U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
PHILADELPHIA, PA.

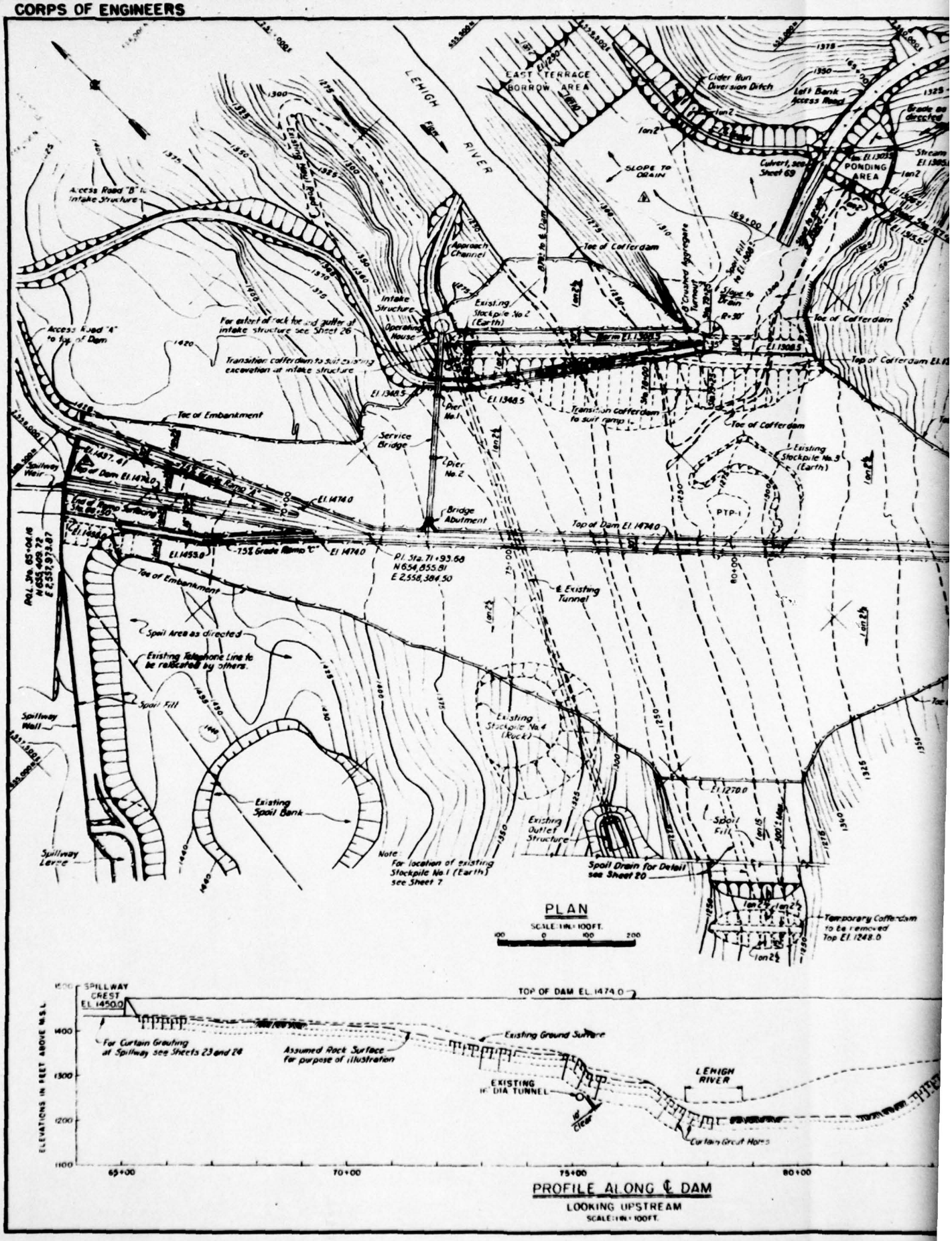
DRAWN BY G.A.A.	LEHIGH RIVER BASIN - LEHIGH RIVER, PA.
TRACED BY H.S.L.	BEAR CREEK RESERVOIR
CHECKED BY G.G.A.	GEOLOGIC SECTION
REVIEWED J.L.L.	DAM AND SPILLWAY
SUPERVISED	
APPROVED	DATE
SHEET 17 OF 73	SCALE: 1 IN. = 50 FT.
DRAWER NO. 281	DRAWING NO. 26917

PREPARED BY
OFFICE OF THE DISTRICT ENGINEER
BALTIMORE DISTRICT

15 FEB 67

(17)

CORPS OF ENGINEERS



PLAN

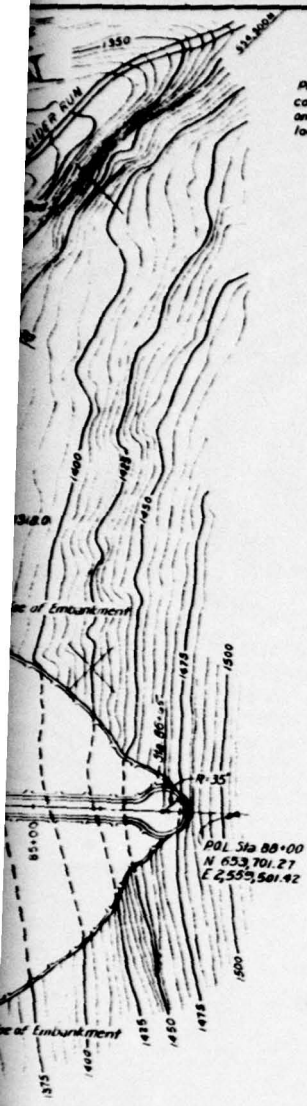
SCALE: 1 IN = 100 FT.

PROFILE ALONG ℄ DAM

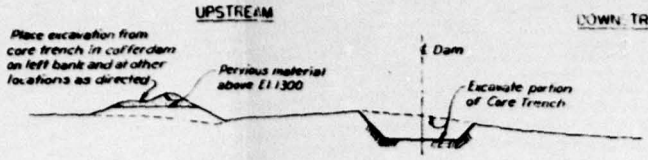
LOOKING UPSTREAM

SCALE: 1 IN = 100 FT.

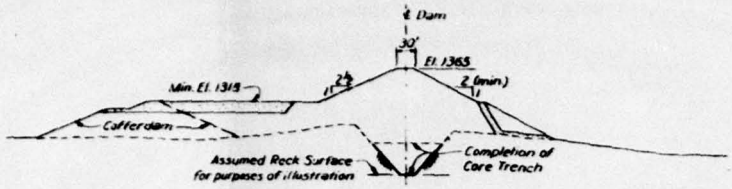
U.S. ARMY



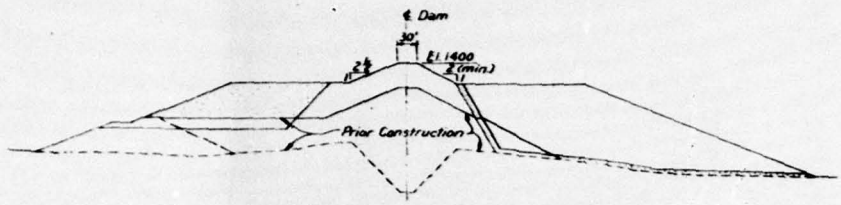
Note:
The spacing and depth of holes for the curtain grouting are shown for purpose of illustration. The actual spacing and depth of holes will be determined by the contracting Officer as the work progresses.



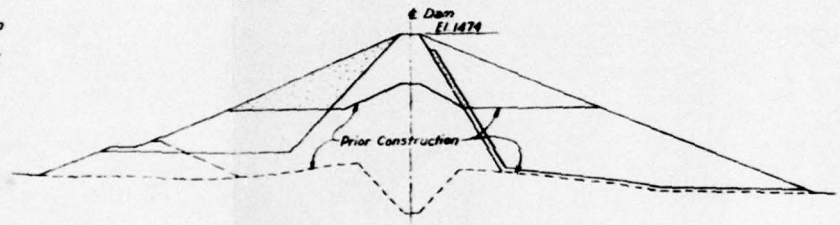
END OF FIRST CONSTRUCTION SEASON
STA. 80+00±



END OF SECOND CONSTRUCTION SEASON
STA. 79+00±



END OF THIRD CONSTRUCTION SEASON
STA. 79+00±



END OF FOURTH CONSTRUCTION SEASON
STA. 79+00±

TYPICAL SECTIONS - CONSTRUCTION STAGES

NOT TO SCALE

GENERAL NOTES:
For General Notes see Sheet 6

REFERENCES:

General Plan	Sheet 6
Foundation Exploration	Sheets 7 to 17 incl.
Embankment Typical Sections	Sheet 19
Embankment Typical Details	Sheet 20
Spillway	Sheets 21 to 24 incl.
Right Bank Access Roads	Sheet 62
Left Bank Access Road	Sheet 68

AS-BUILT

DIVISION	DATE	DESCRIPTION	BY	APPD
		REVISED TO SHOW AS BUILT		
		LIMIT OF SPOIL AREA REVISED		
		Alteration of intersection of R & Rp = A Revised		

CORPS OF ENGINEERS
U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
PHILADELPHIA, PA.

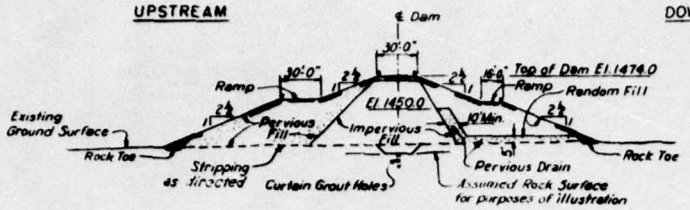
DRAWN BY E.P.
TRACED BY H.B.L.
CHECKED BY L.B.P.
REVIEWED
SUBMITTED
APPROVED
DATE

LEHIGH RIVER BASIN - LEHIGH RIVER, PA.
BEAR CREEK RESERVOIR
EMBANKMENT
PLAN AND PROFILE

SHEET 18 OF 73
SCALE: AS SHOWN
DRAWER NO. 281
DRAWING NO. 26918

PREPARED BY
OFFICE OF THE DISTRICT ENGINEER
PHILADELPHIA DISTRICT

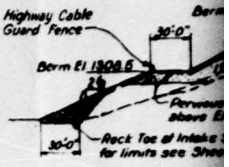
CORPS OF ENGINEERS

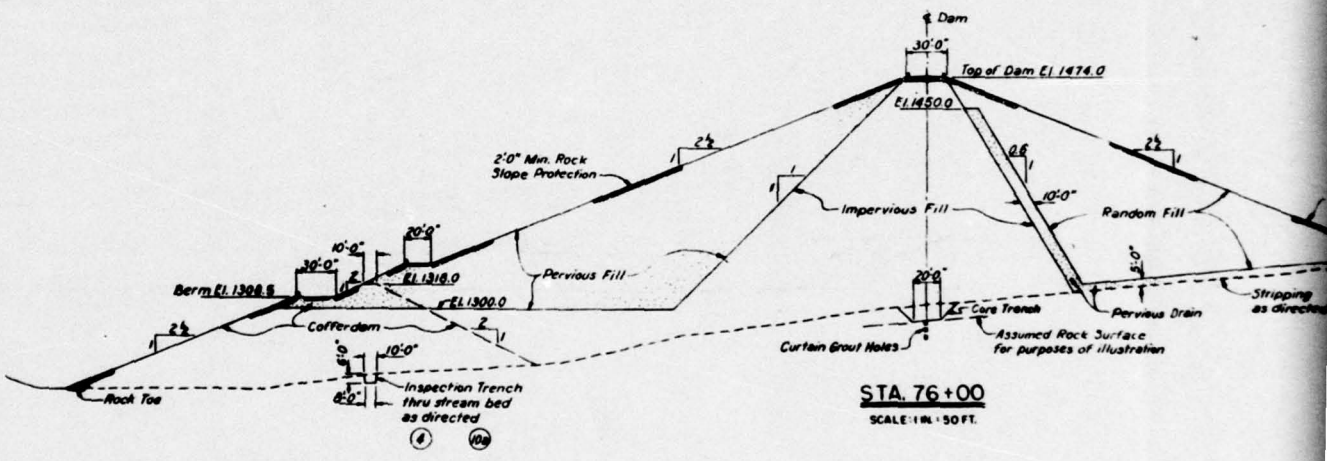


STA. 68+00

SCALE: 1 IN. = 50 FT.

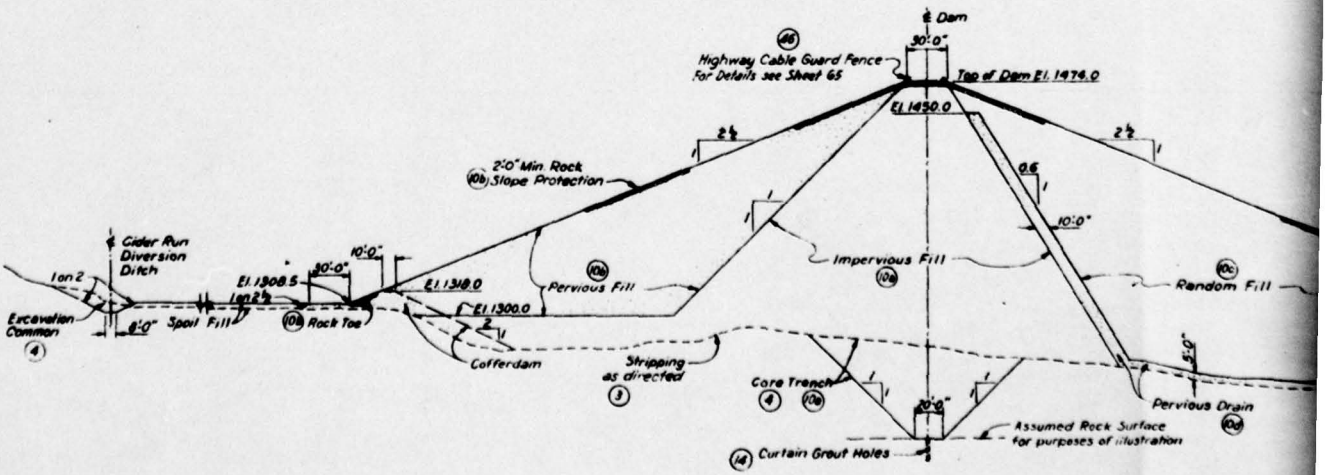
50 0 50 100





STA. 76+00

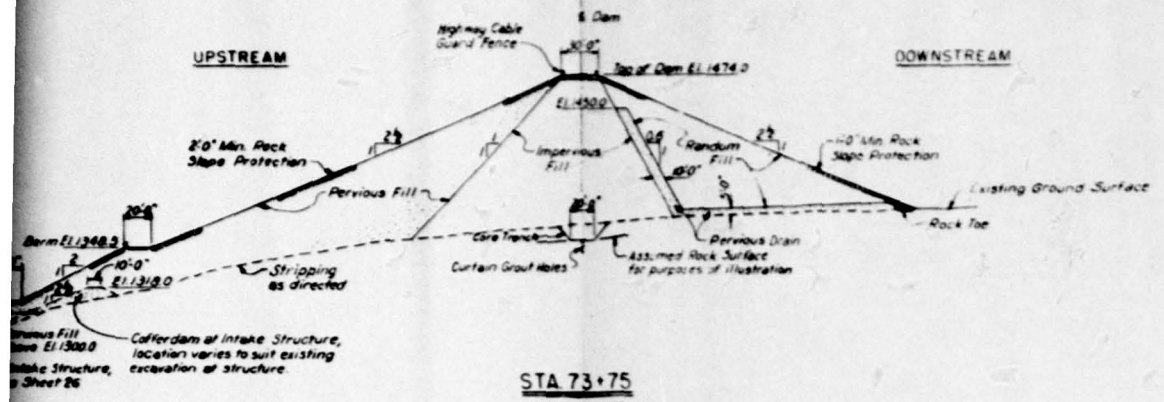
SCALE: 1 IN. = 50 FT.



STA. 80+00

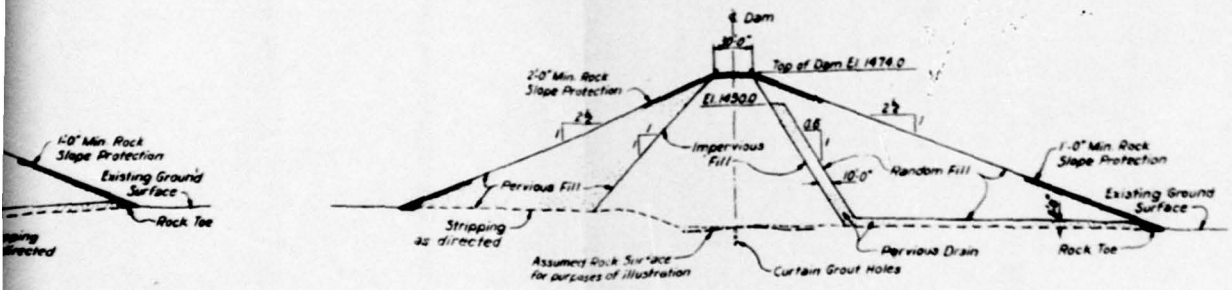
SCALE: 1 IN. = 50 FT.

U.S. ARMY



STA 73+75

SCALE: 1 IN. = 50 FT.



STA 84+00

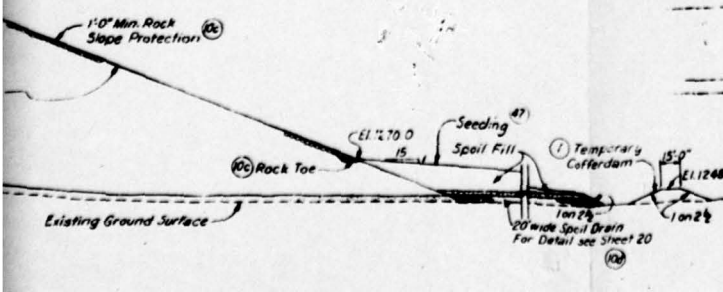
SCALE: 1 IN. = 50 FT.

GENERAL NOTES:

Surplus rock from required excavation shall be incorporated in the dam embankment by increasing the thickness of the rock slope protection.
For additional General Notes see Sheet 6

REFERENCES:

For References see Sheet 18



REVISION	DATE	DESCRIPTION	BY	APPD

CORPS OF ENGINEERS
U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
PHILADELPHIA, PA.

LEHIGH RIVER BASIN - LEHIGH RIVER, PA.
BEAR CREEK RESERVOIR

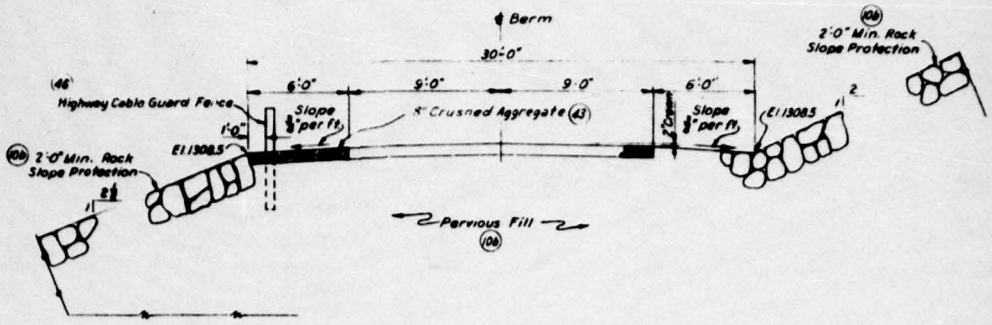
EMBANKMENT

TYPICAL SECTIONS

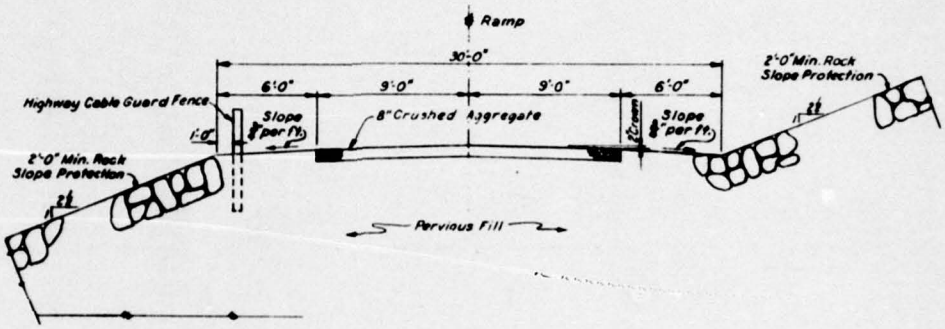
DRAWN BY E.P.	
TRACED BY H.B.L.	
CHECKED BY L.S.P.	
REVIEWED J.A.C. SAFETY BRANCH	
SUBMITTED	
CHIEF, DESIGN BRANCH	
CHIEF, ENGINEERING DIVISION	APPROVED DATE
SHEET 10 OF 73	SCALE: 1 IN. = 50 FT.
DRAWER NO. 281	DRAWING NO. 26919

PREPARED BY
OFFICE OF THE DISTRICT ENGINEER
BALTIMORE DISTRICT

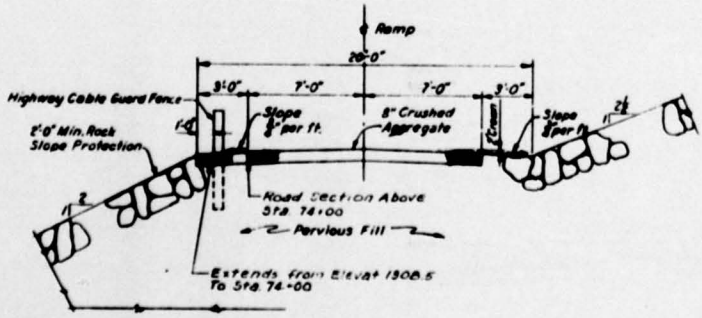
CORPS OF ENGINEERS



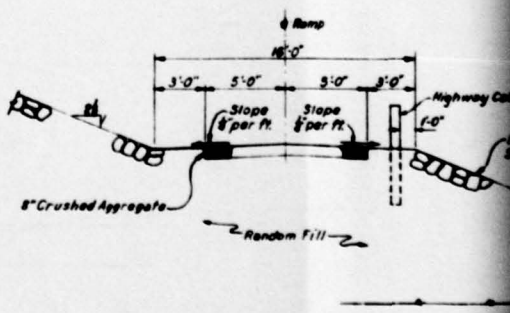
BERM EL. 1308.5



RAMP "A"



RAMP "B"



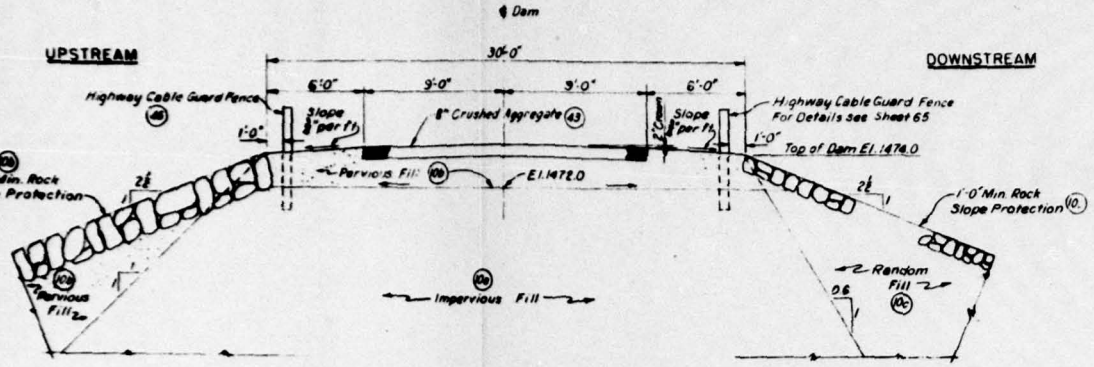
RAMP "C"

TYPICAL SECTIONS - RAMPS AND BERMS

SCALE: 1/4 IN. = 1 FT.

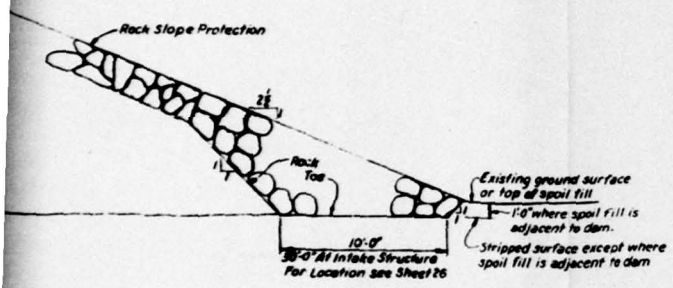
1 2 3 4 5 6

U. S. ARMY



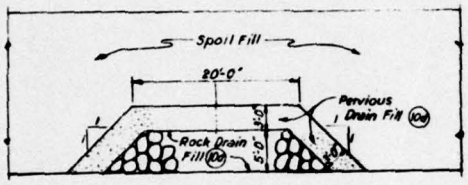
TYPICAL SECTION AT TOP OF DAM

SCALE: 1/4 IN.=1 FT.



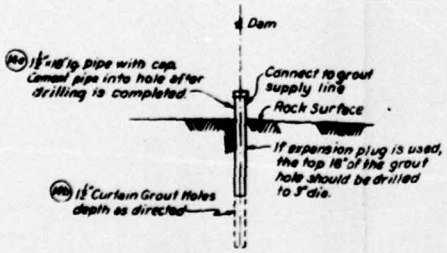
TYPICAL ROCK TOE

SCALE: 1/4 IN.=1 FT.



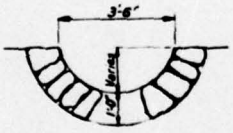
SPOIL DRAIN

SCALE: 1/8 IN.=1 FT.



CURTAIN GROUT HOLES

SCALE: 1 IN.=1 FT.



ROCK GUTTER (13)

SCALE: 1/2 IN.=1 FT.

AS-BUILT

GENERAL NOTES:
For General Notes see Sheets 6 and 19

REFERENCES:
For References see Sheet 18

REVISION	DATE	DESCRIPTION	BY	APPD
1	25 JAN 61	REVISED TO SHOW AS BUILT	GD	

CORPS OF ENGINEERS
U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
PHILADELPHIA, PA.

DRAWN BY E.P.
TRACED BY S.C.
CHECKED BY L.S.P.
REVIEWED J.H.C. SAFETY BRANCH
SUBMITTED (CHIEF, ENGR. DIV.)
APPROVED (CHIEF, ENGINEERING DIVISION)

LEHIGH RIVER BASIN - LEHIGH RIVER, PA.
BEAR CREEK RESERVOIR
EMBANKMENT
TYPICAL DETAILS

DATE 1961

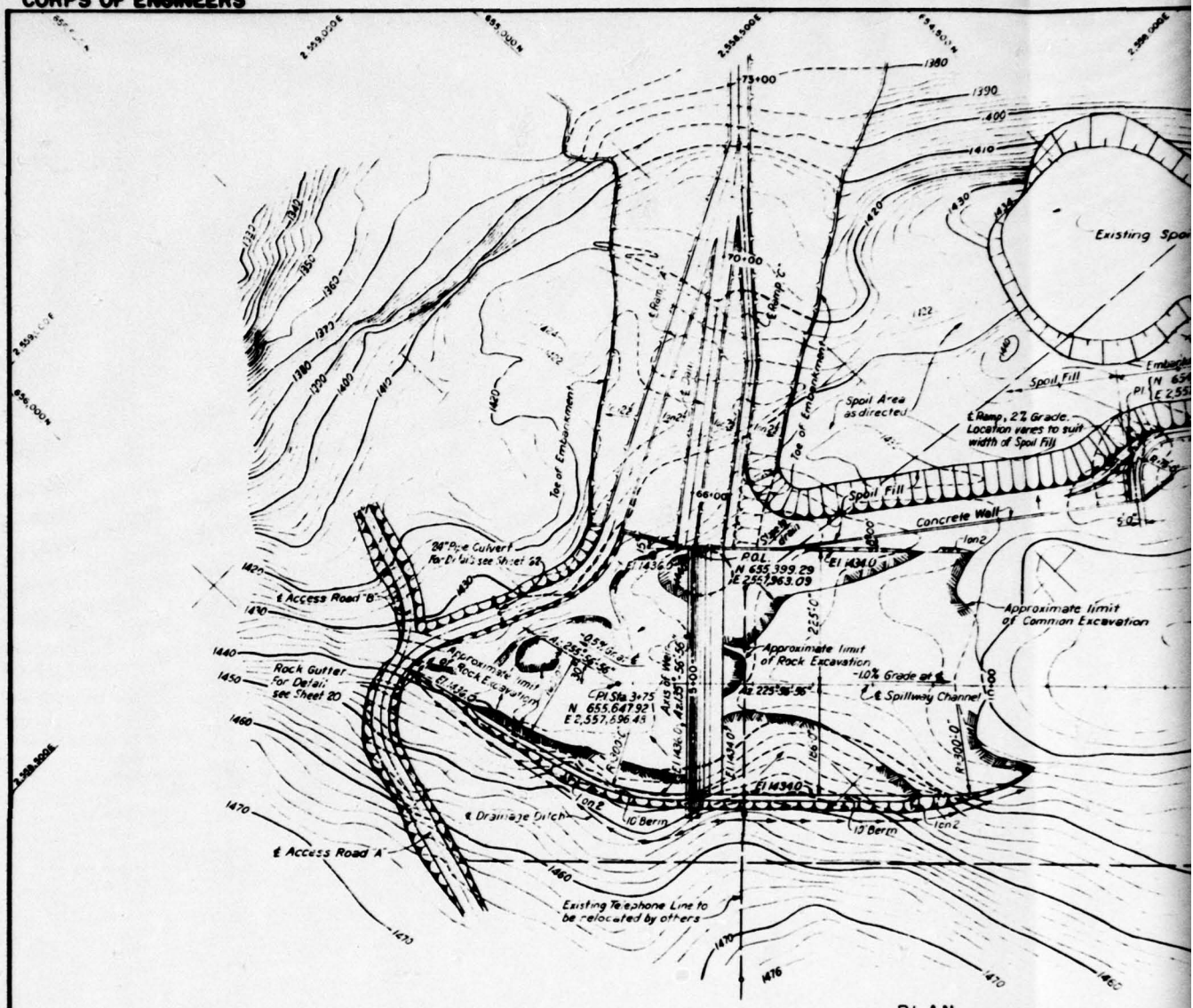
SHEET 20 OF 75 SHEETS
SCALE: AS SHOWN
DRAWER NO. 281
DRAWING NO. 26920

PREPARED BY OFFICE OF THE DISTRICT ENGINEER BALTIMORE DISTRICT

DONE IN ACCORDANCE WITH AEC APPROVED SAFETY REQUIREMENTS

20

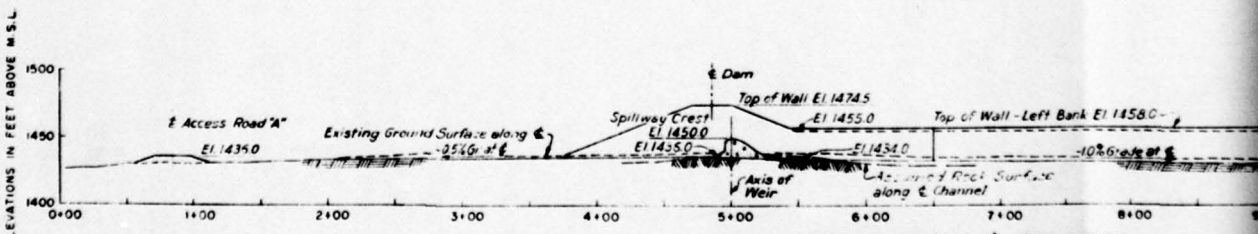
CORPS OF ENGINEERS



PLAN

SCALE 1 IN. = 100 FT.

100 0 100 200

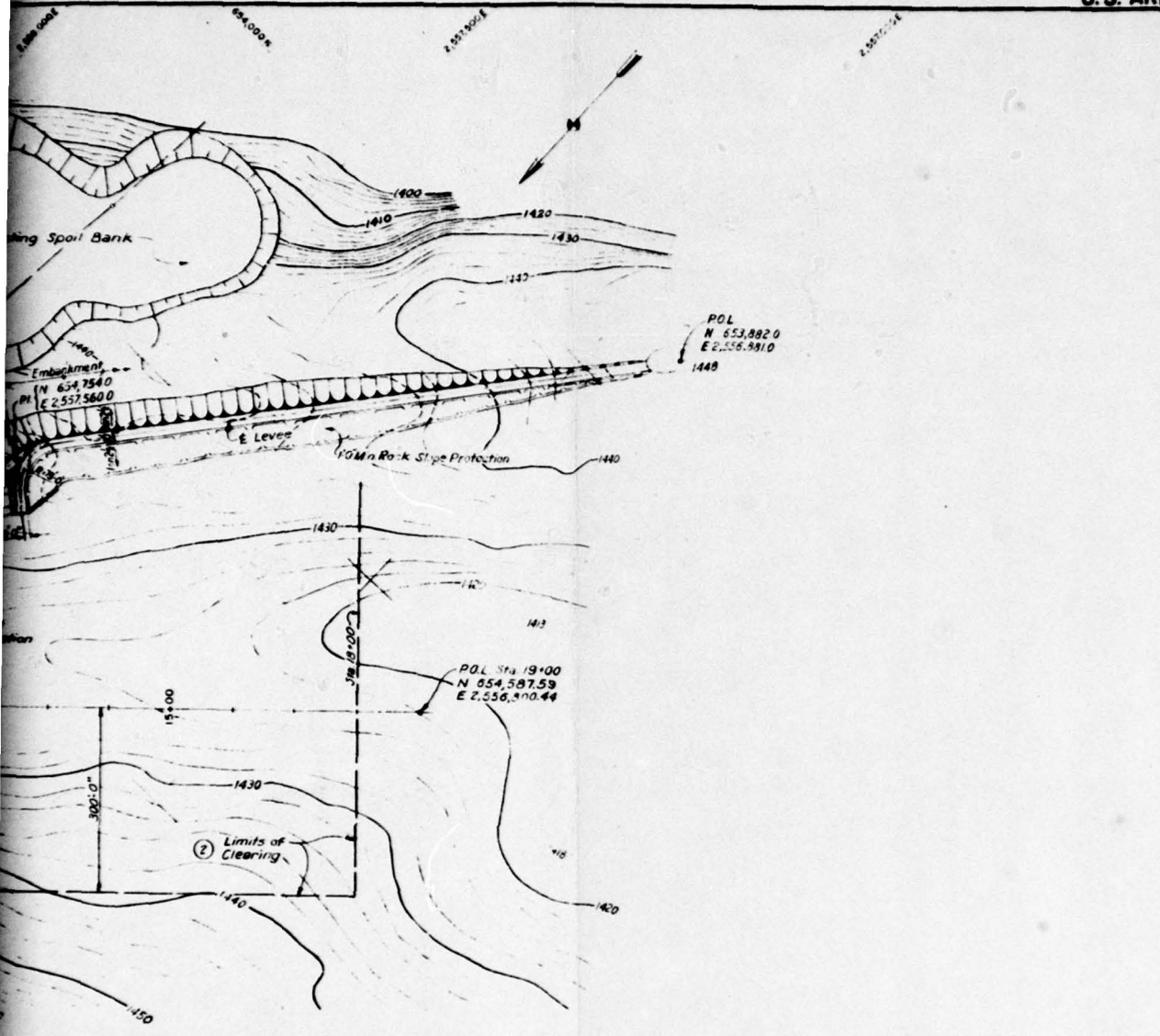


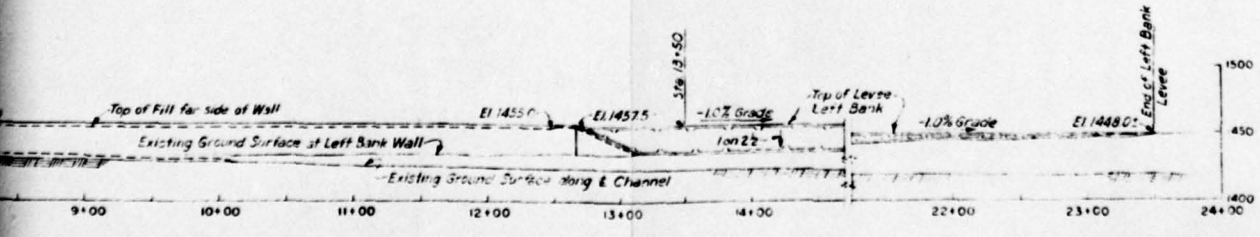
PROFILE ALONG ℄ SPILLWAY

SCALE 1 IN. = 50 FT.

50 0 50 100

U.S. ARMY





GENERAL NOTES:

For General Notes see Sheet 6.

REFERENCES:

General Plan	Sheet 6
Foundation Exploration	Sheets 7 to 17 incl.
Embankment	Sheets 18 to 20 incl.
Spillway Sections	Sheet 22
Spillway Weir and Wall Details	Sheets 23 and 24
Right Bank Access Roads	3 sheets

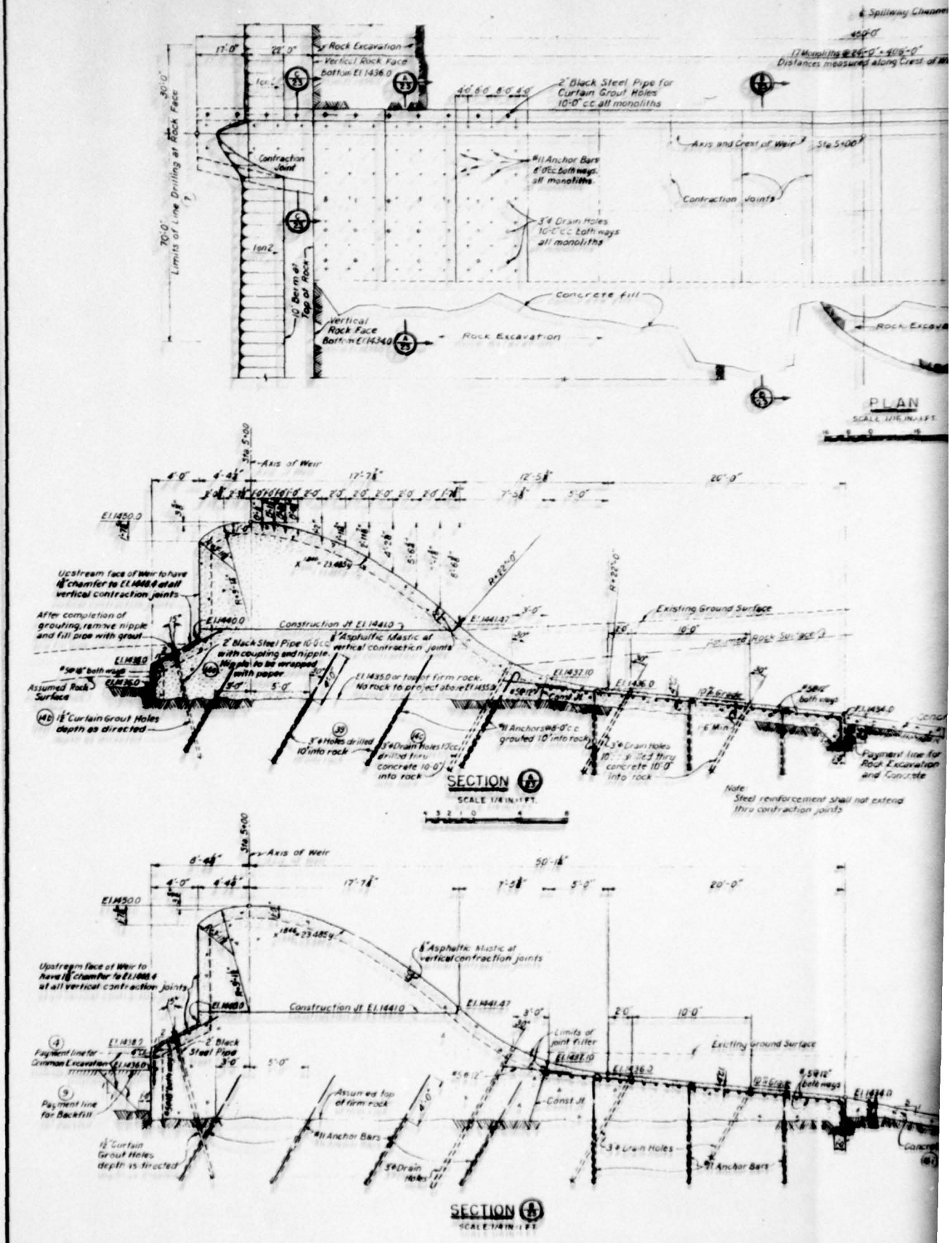
REVISION	DATE	DESCRIPTION	BY	APPD

CORPS OF ENGINEERS
U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
PHILADELPHIA, PA.

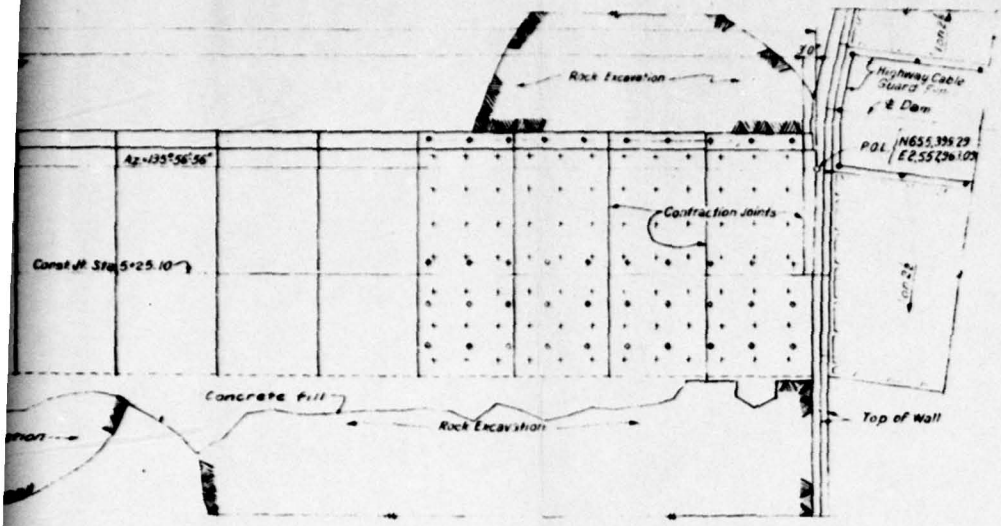
DRAWN BY G.A.A.	LEHIGH RIVER BASIN - LEHIGH RIVER, PA
TRACED BY L.G.S.	BEAR CREEK RESERVOIR
CHECKED BY M.Z.	SPILLWAY
DESIGNED J.L.C. SAFETY BOARDS	PLAN AND PROFILE
SUBMITTED	
APPROVED	DATE
SHEET 1 OF 24	SCALE: AS SHOWN
DRAWER NO 281	DRAWING NO 26921

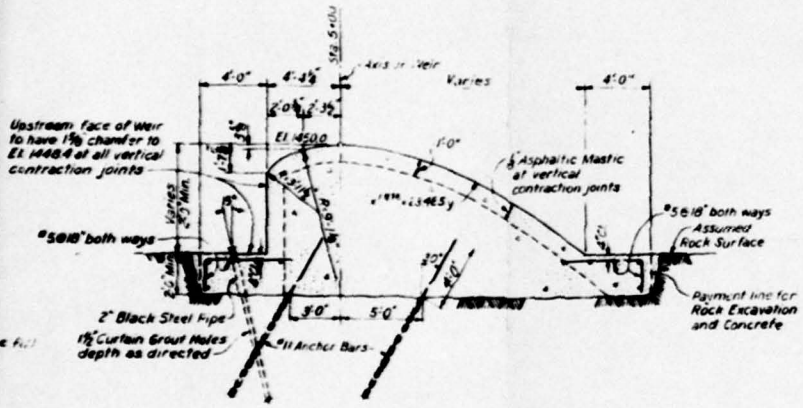
PREPARED BY
OFFICE OF THE DISTRICT ENGINEER
BALTIMORE DISTRICT

CORPS OF ENGINEERS



U.S. ARMY





SECTION 4/23

SCALE 1/4 IN. = 1 FT.

GENERAL NOTES

Concrete weir will be paid for under Item [illegible]
Concrete paving shown from at Contraction Joint Sta. 5+25.10 will be paid for under Item [illegible]
Reinforcing steel splices shall lap 20 diameters unless otherwise noted or directed.
Alternate monoliths in the weir shall be maintained one lift above the intervening monolith and the paving shall be placed on alternate slabs.
For additional General Notes see Sheet 6

REFERENCES

For References see Sheet 21

AS BUILT

NO.	DATE	REVISION DESCRIPTION	BY	APPD
1	5/1/64	REVISED TO SHOW AS BUILT	[illegible]	

CORPS OF ENGINEERS
U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
PHILADELPHIA, PA.

DRAWN BY G.A.A.	LEHIGH RIVER BASIN - LEHIGH RIVER, PA.
TRACED BY S.R.	BEAR CREEK RESERVOIR
CHECKED BY L.S.P.	SPILLWAY
REVIEWED J.L.C. ASSISTANT ENGINEER	WEIR DETAILS
SUBMITTED [illegible]	
RECOMMENDED [illegible] DATE	APPROVED [illegible] DATE
SHEET 23 OF 73	SCALE AS SHOWN
DRAWER NO. 281	DRAWING NO. 26923

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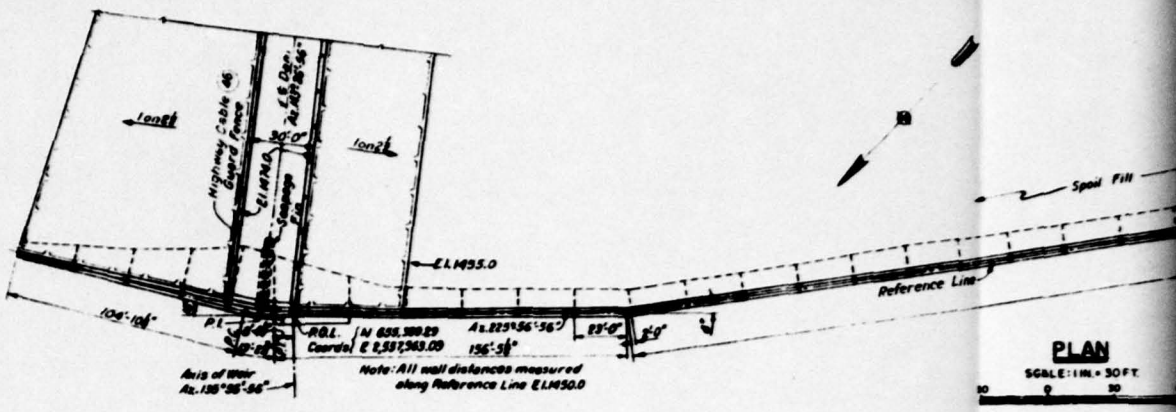
OFFICE OF THE DISTRICT ENGINEER
BALTIMORE DISTRICT

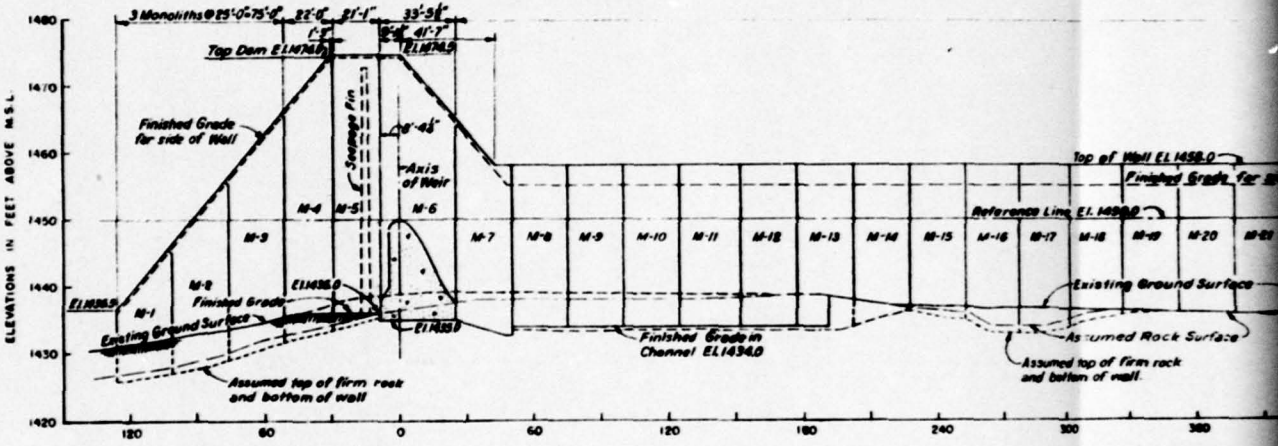
23

CORPS OF ENGINEERS



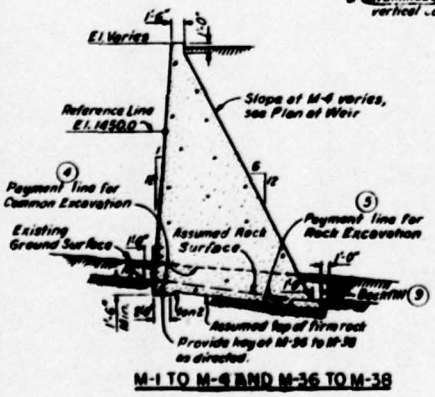
PLAN

SCALE: 1 IN. = 30 FT.

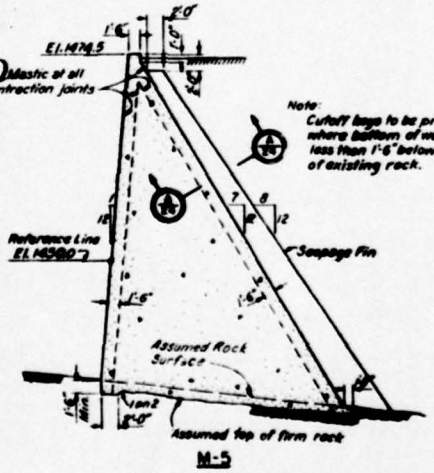


PROFILE

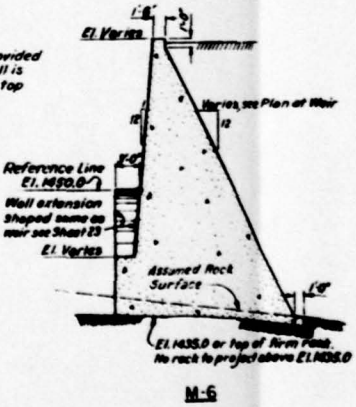
SCALE: HORIZ. 1 IN.= 30 FT.
VERT. 1 IN.= 10 FT.



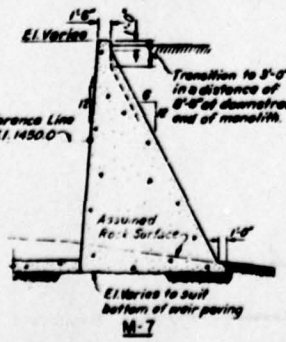
M-1 TO M-9 AND M-36 TO M-38



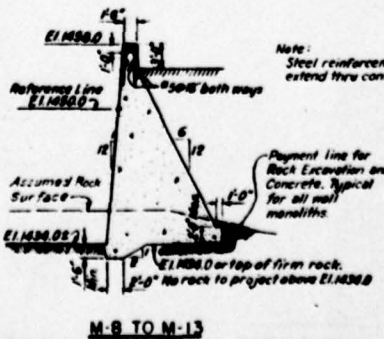
M-5



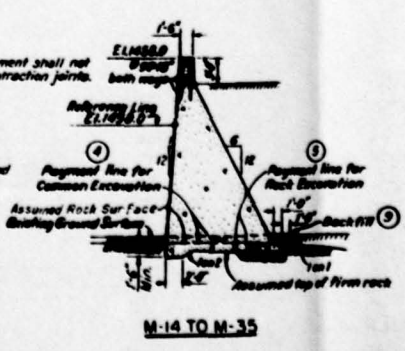
M-6



M-7



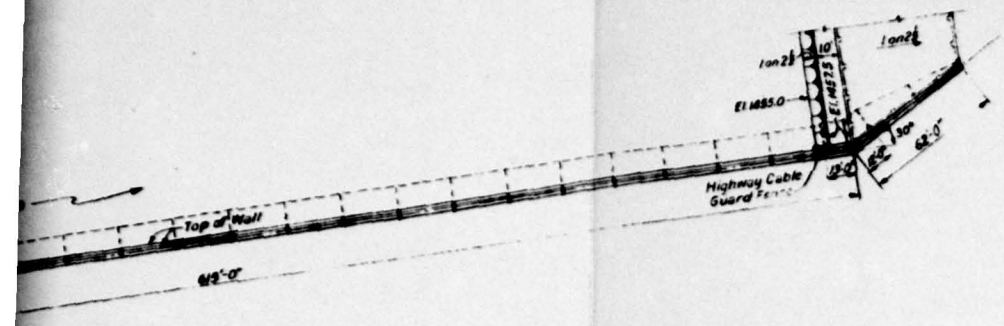
M-8 TO M-13



M-14 TO M-35

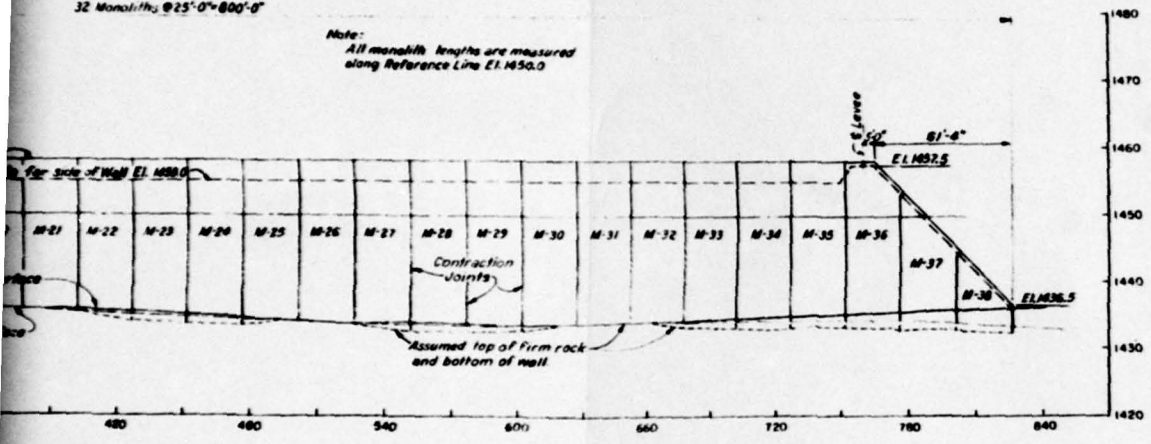
TYPICAL MONOLITH SECTIONS

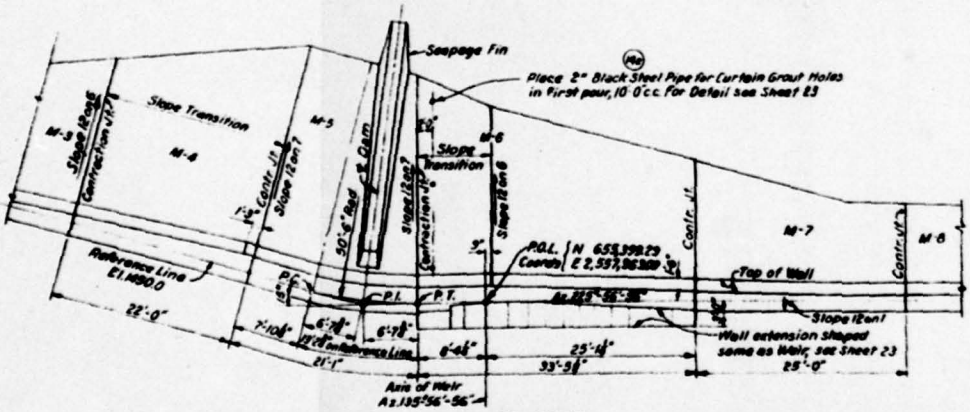
U.S. ARMY



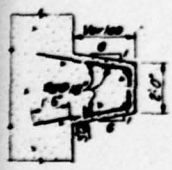
32 Monoliths @ 25'-0" = 800'-0"

Note:
All monolith lengths are measured along Reference Line El. 1450.0

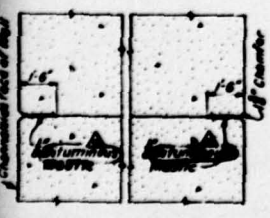




PLAN AT WEIR
SCALE: 1/8 IN. = 1 FT.
4 0 4 8 12 16 20



SECTION A
SCALE: 3/8 IN. = 1 FT.
3 2 1 0



CONTRACTION JOINT
SCALE: 3/8 IN. = 1 FT.

GENERAL NOTES:
Concrete walls will be paid for under Item (89)
All exposed edges of concrete shall be chamfered 1½ inches unless otherwise noted.
Horizontal construction joints shall be located to suit field conditions. Spacing of intermediate joints shall not exceed 10 feet and the top joint shall be located not more than 5 feet from top of wall.
Alternate monoliths in the wall shall be maintained at least one lift above the intervening monolith.
For additional General Notes see Sheet 6.
(A) Chamfers at top of wall shall be filled flush with bituminous mastic.

REFERENCES:
For References see Sheet 21

PREPARED IN
OFFICE OF THE DISTRICT ENGINEER
BALTIMORE DISTRICT

REVISION	DATE	DESCRIPTION	BY	APPD
(A)		42" Construction Joint P. 22, Note Added		

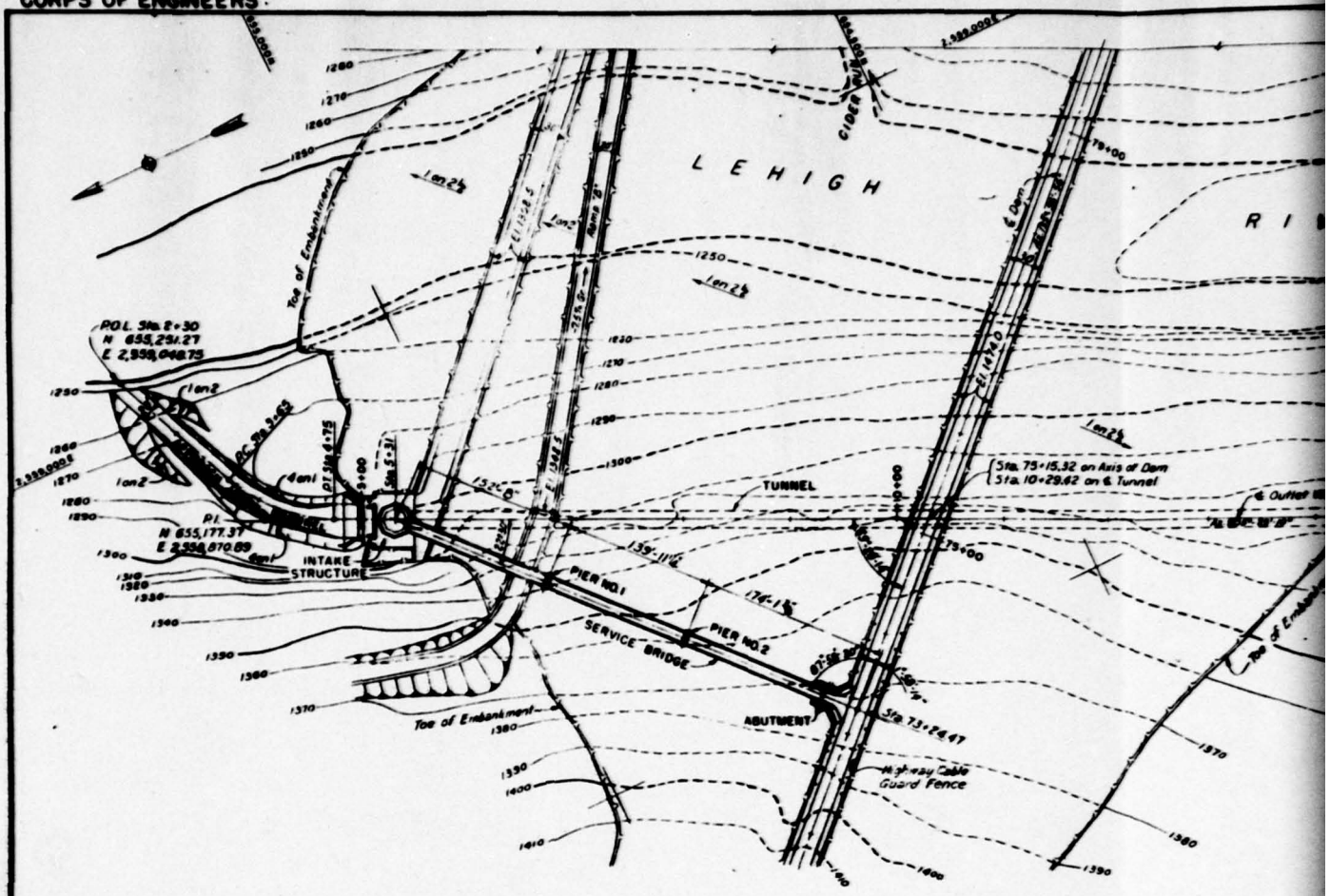
CORPS OF ENGINEERS
U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
PHILADELPHIA, PA.

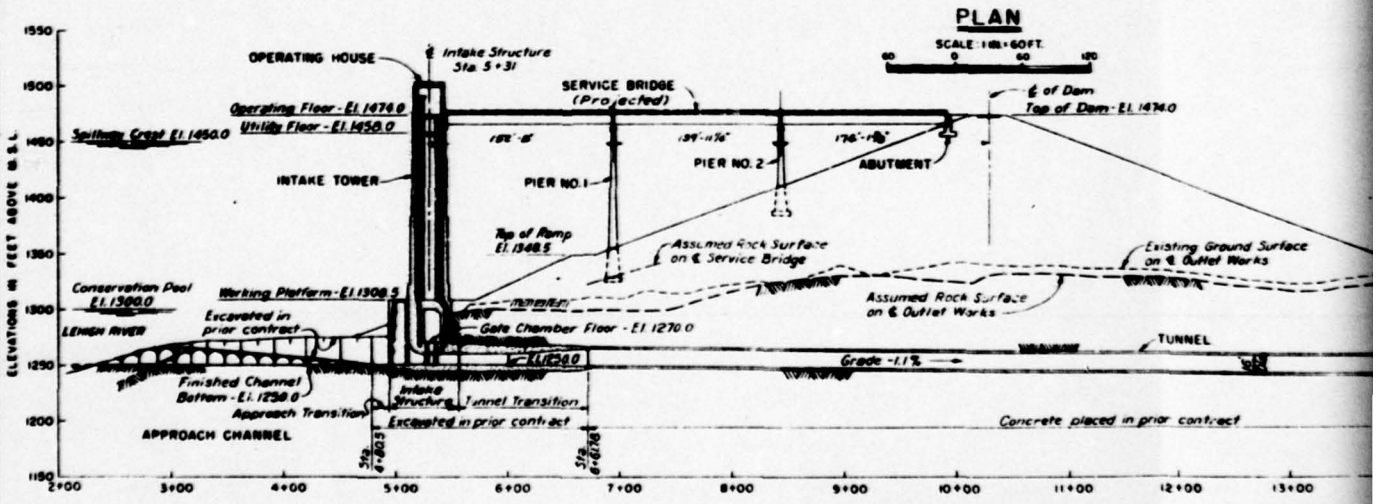
DRAWN BY	E.P.
TRACED BY	S.E.
CHECKED BY	L.S.P.
REVIEWED	J.L.C.
SUBMITTED	
RECOMMENDED	
APPROVED	
DATE	

LEHIGH RIVER BASIN - LEHIGH RIVER, PA
BEAR CREEK RESERVOIR
SPILLWAY
WALL DETAILS

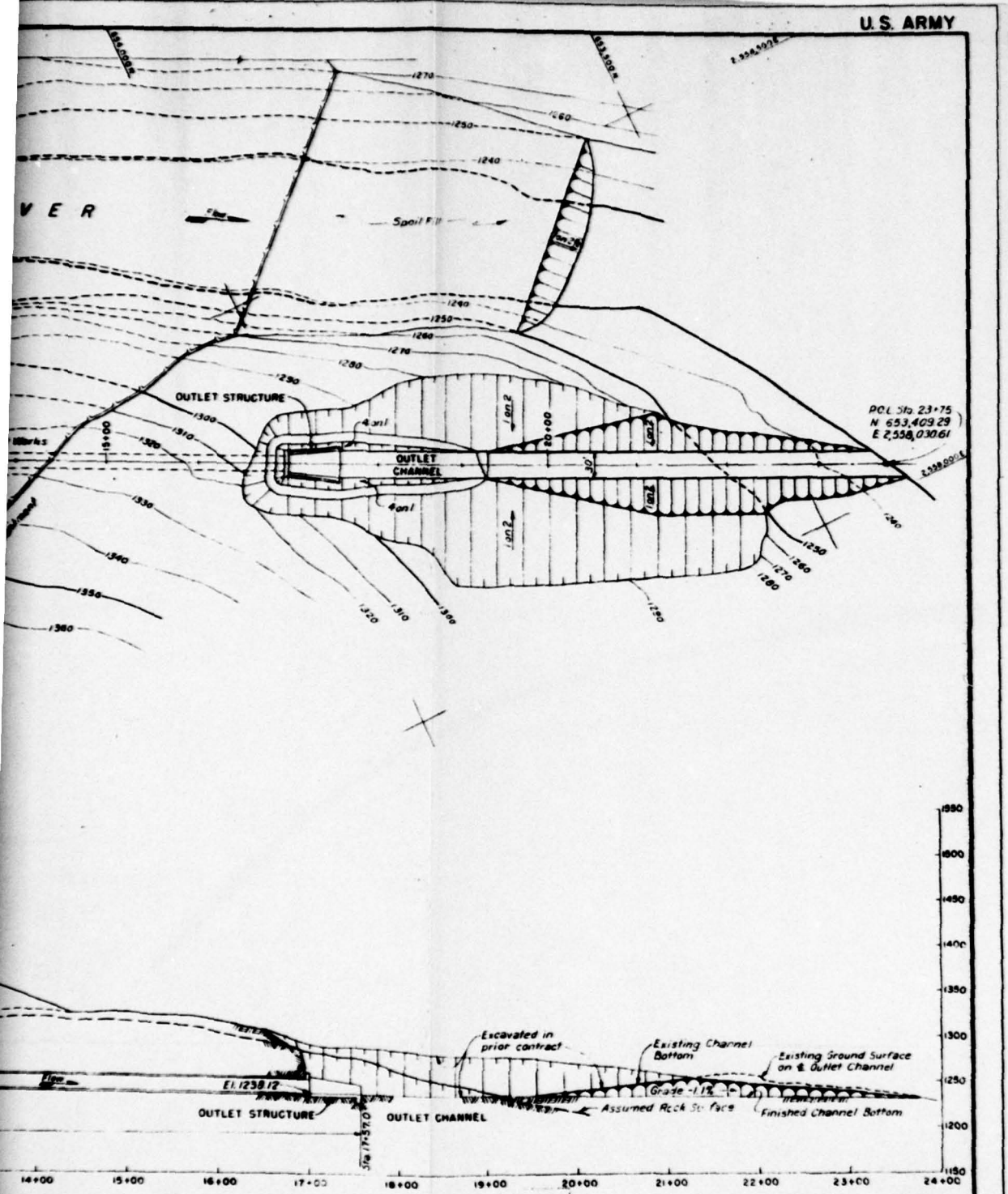
SHEET 24 OF 73
SCALE: AS SHOWN
DRAWER NO. 281
DRAWING NO. 26924

CORPS OF ENGINEERS.





U.S. ARMY



GENERAL NOTES:

Portions of excavation in the upstream and downstream channels shall be left in place to act as cofferdams until diversion is directed.
For General Notes see Sheet 6

REFERENCES:

General Plan	Sheet 6
Embankment	Sheets 18 to 20 incl
Approach Channel	Sheets 26 and 27
Intake Substructure	Sheets 28 to 31 incl
Tunnel Junction	Sheet 32 and 33
Intake Tower	Sheets 34 to 39 incl
Service Bridge	Sheets 53 to 57 incl
Outlet Channel	Sheet 58

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BALTIMORE DISTRICT

NO.	DATE	DESCRIPTION	BY	APPD
21	18 JAN	REVISED TO SHOW AS-BUILT		

CORPS OF ENGINEERS
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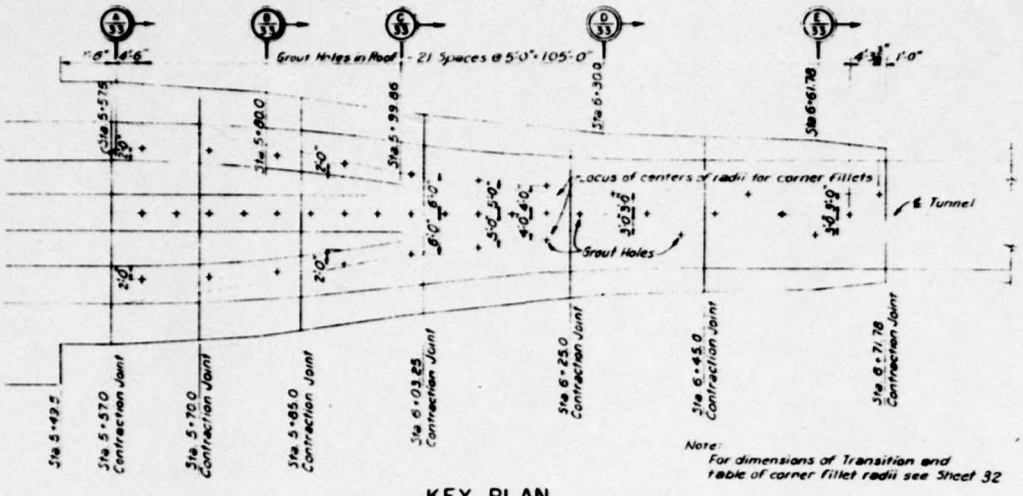
OFFICE OF THE DISTRICT ENGINEER
PHILADELPHIA, PA.

LEHIGH RIVER BASIN - LEHIGH RIVER, PA.
BEAR CREEK RESERVOIR

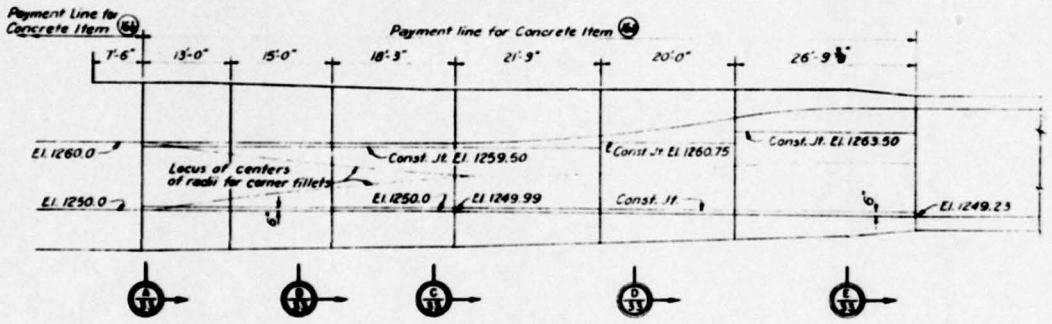
OUTLET WORKS
PLAN AND PROFILE

DRAWN BY	E.P.
TRACED BY	H.S.L.
CHECKED BY	N.Z.
SUBMITTED	J.L.G. CHIEF, ENGR. DIV.
RECOMMENDED	Chief, Eng. Div.
APPROVED	Chief, Const. Div.
DATE	
SHEET 24 OF 73	SCALE: 1 IN. = 60. '
DRAWER NO. 281	DRAWING NO. 26925



KEY PLAN

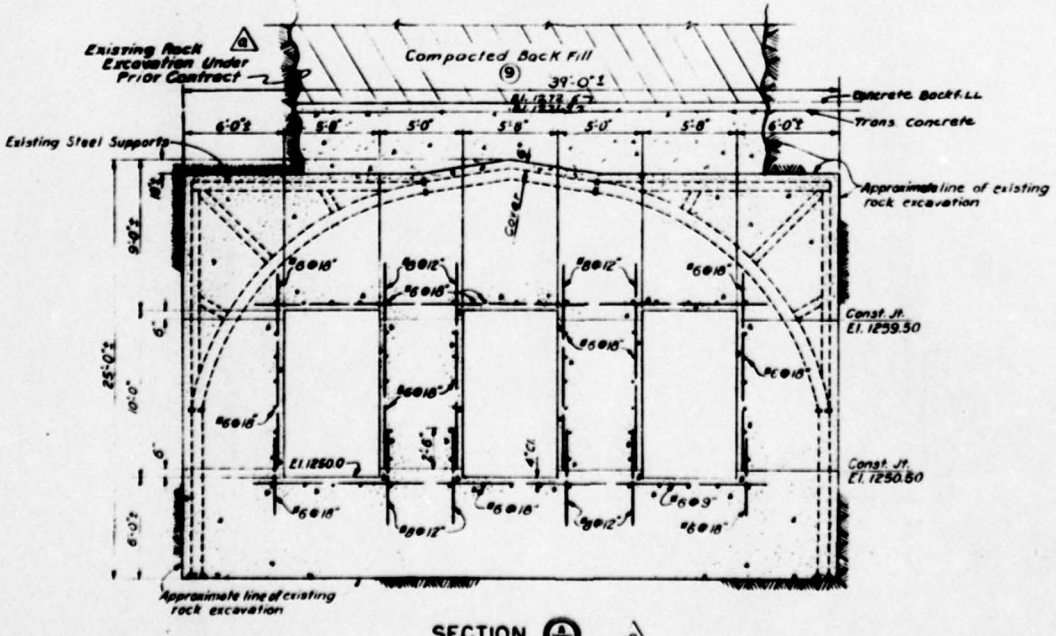
SCALE: 1 IN. = 10 FT.



PROFILE

SCALE: 1 IN. = 10 FT.

10 0 10 20



SECTION

SCALE 1/4 IN. = 1 FT.

4 3 2 1 0 4 8

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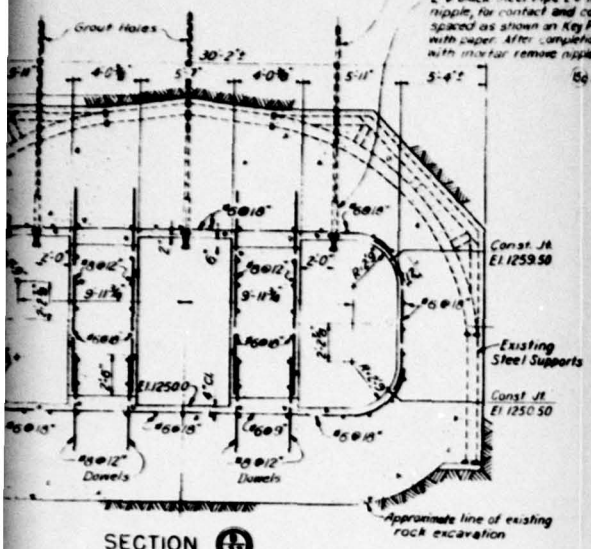
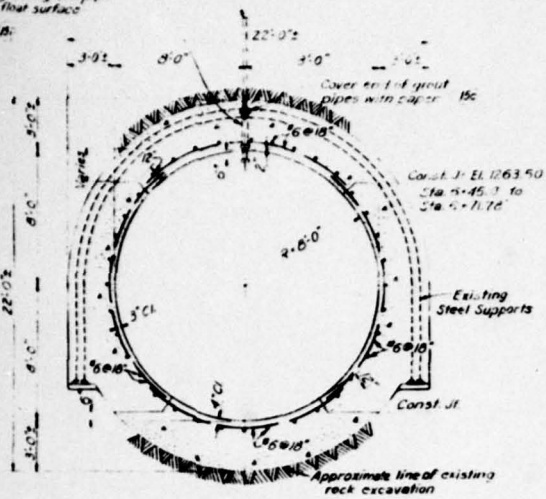
1½"ø Consolidation grout holes, drilled approximately 5'-0" into solid rock after contact grouting has been completed. (15g)

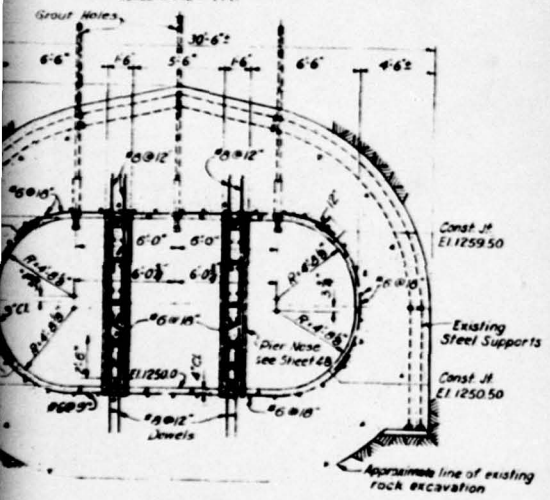
2"ø Black Steel Pipe 2'-0" long with coupling and nipple, for contact and consolidation grouting, spaced as shown on Key Plan. Nipple to be wrapped with paper. After completion of grouting fill pipe with mortar, remove nipple and float surface. (15a thru 15f)



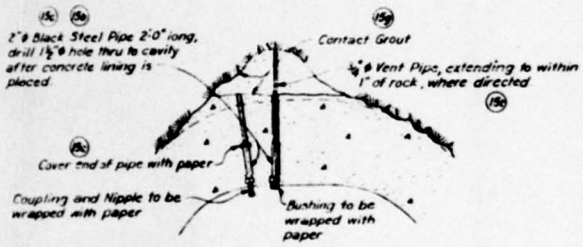
SECTION (15f)
SCALE 1/4 IN. = 1 FT.



SECTION (15g)
SCALE 1/4 IN. = 1 FT.

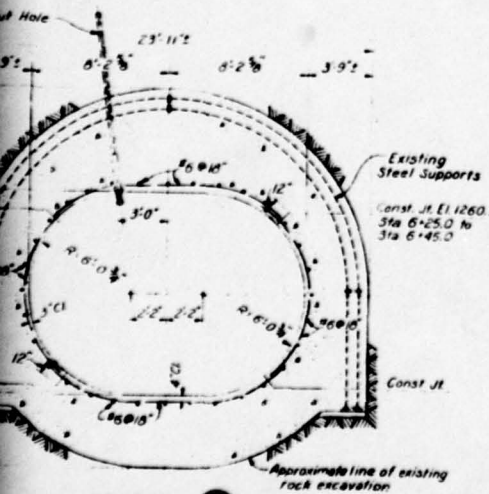


SECTION (15g)
SCALE 1/4 IN. = 1 FT.



EXCESSIVE OVERBREAK CONTACT GROUTING DETAIL

SCALE 1/4 IN. = 1 FT.



SECTION (15g)
SCALE 1/4 IN. = 1 FT.

GENERAL NOTES:

Grout holes in roof shall be relocated as directed to maintain 6 inch minimum clearance from the edge of existing steel tunnel transition supports and tie rods. For additional General Notes see Sheet 32.

REFERENCES:

For References see Sheet 28

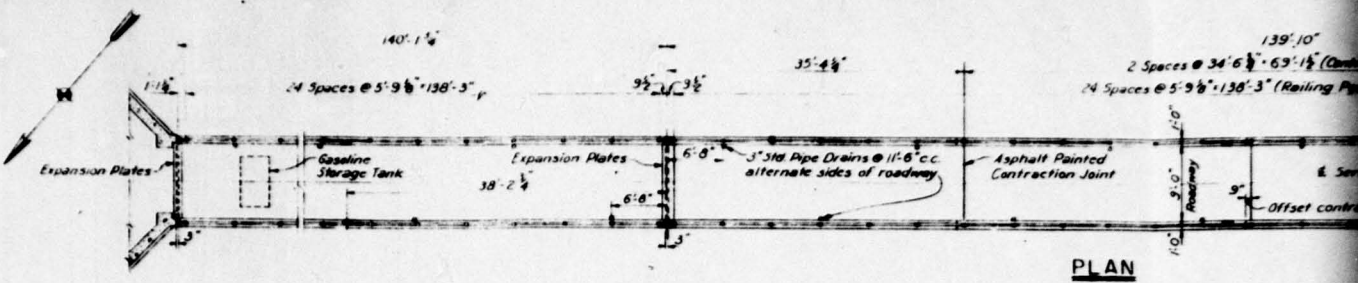
REVISION	DATE	DESCRIPTION	BY	APPD
2	27 JUNE	REVISED TO SHOW AS BUILT	JJO	
1	7 MAY 57	Existing ROCK Surface and S-T (15a) REVISED	FJC	GMK

CORPS OF ENGINEERS
U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
PHILADELPHIA, PA.

DRAWN BY G.P.A.	LEHIGH RIVER BASIN LEHIGH RIVER, PA
TRACED BY H.B.L.	BEAR CREEK RESERVOIR
CHECKED BY H.E.	INTAKE STRUCTURE
REVIEWED J.A.C.	TUNNEL TRANSITION - TYPICAL SECTIONS
SUBMITTED [illegible]	DATE 19 FEB 1957
SHEET 29 OF 73	SCALE: AS SHOWN
DRAWER NO. 281	DRAWING NO. 26933

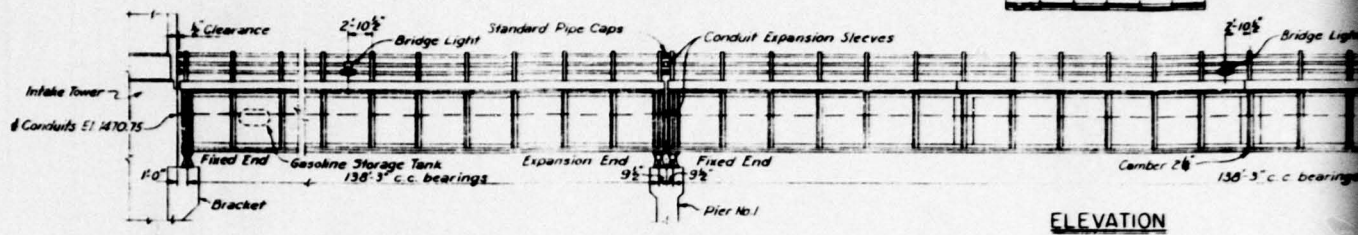
PREPARED BY
OFFICE OF THE DISTRICT ENGINEER
BALTIMORE DISTRICT

RIE OPERATIONS REPRODUCTION [illegible]



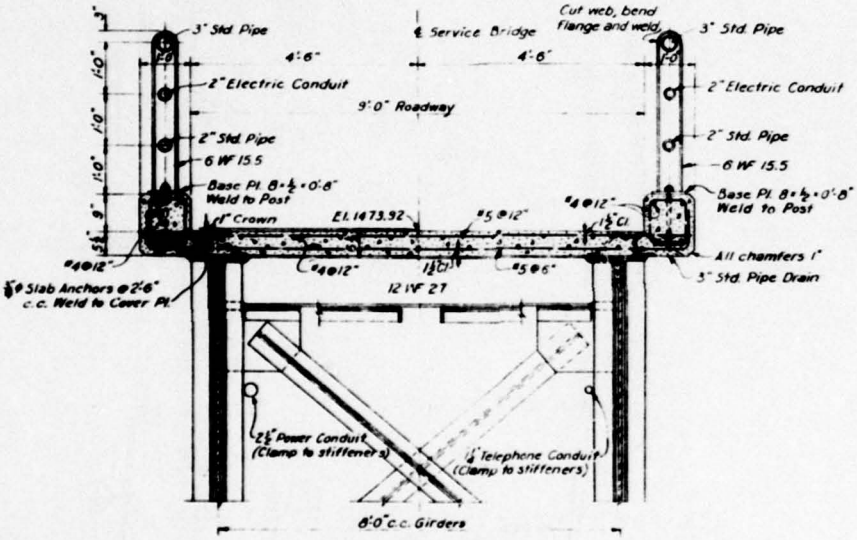
PLAN

SCALE: 1/8 IN. = 1 FT.



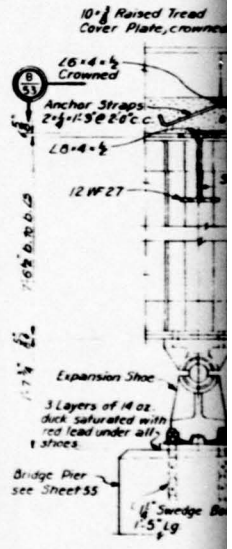
ELEVATION

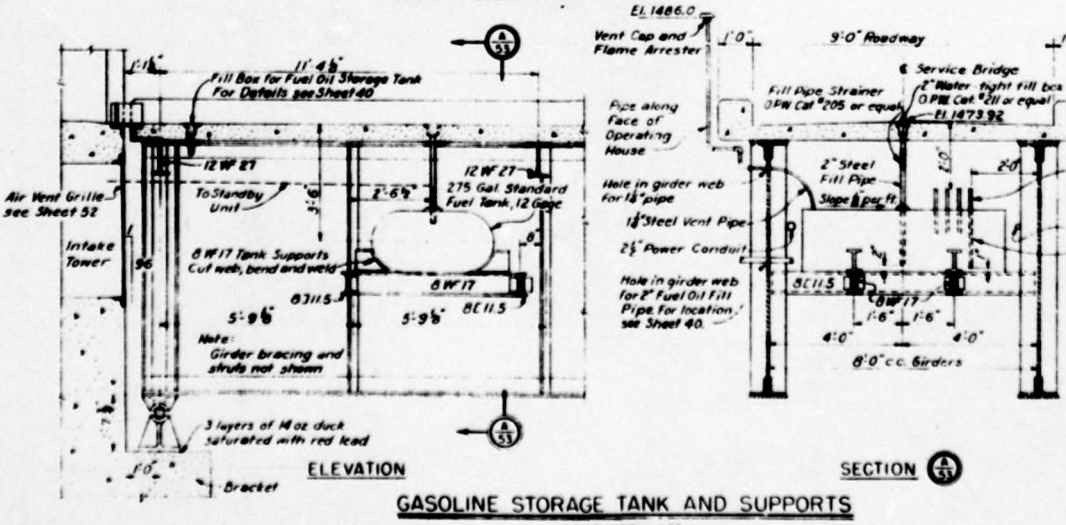
SCALE: 1/8 IN. = 1 FT.



DECK DETAILS

SCALE 3/4 IN. = 1 FT.





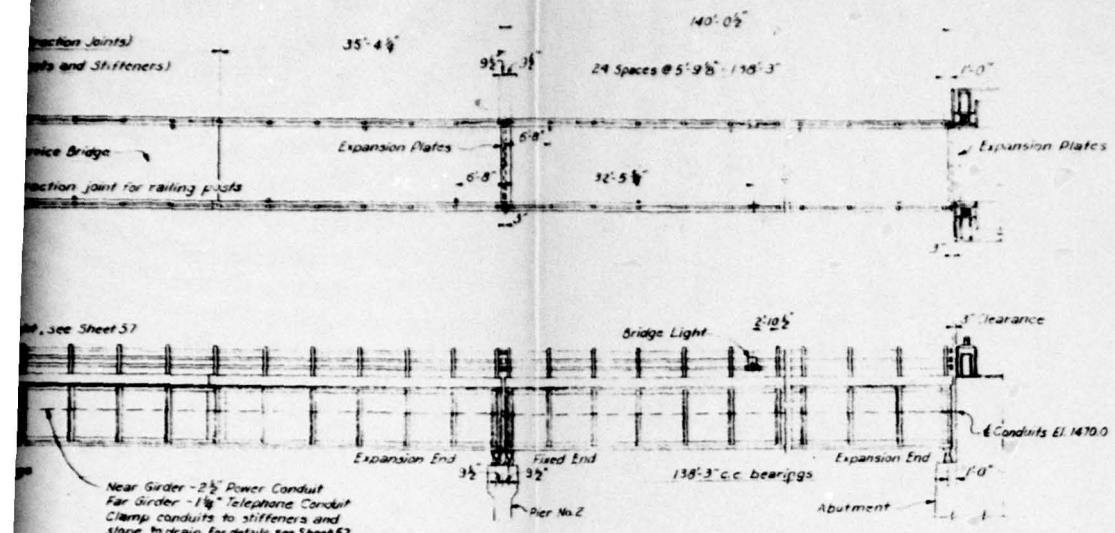
ELEVATION

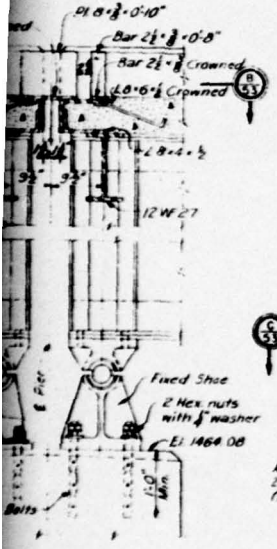
SECTION A/S3

GASOLINE STORAGE TANK AND SUPPORTS

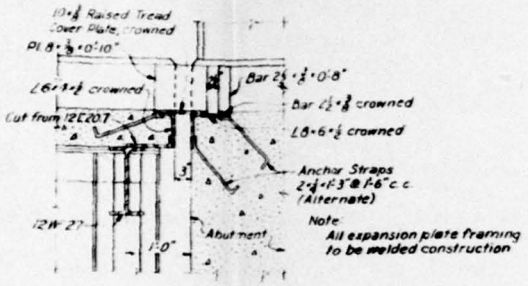
SCALE 1/2 IN. = 1 FT.

U.S. ARMY

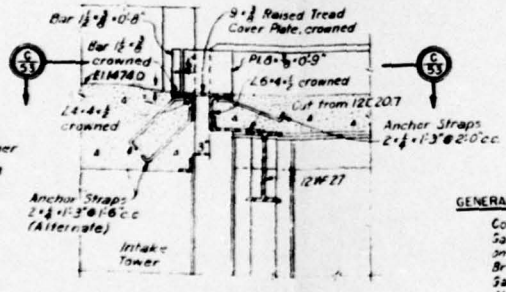




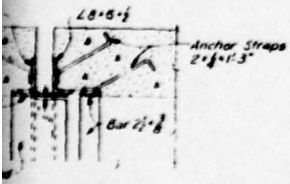
PIER



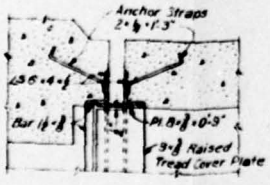
ACCESS ROAD ABUTMENT



OPERATING HOUSE



SECTION (C 53)



SECTION (C 53)

PIER AND ABUTMENT DETAILS

SCALE: 1 IN. = 1 FT.

GENERAL NOTES:

Concrete bridge deck will be paid for under item (16)
Gasoline storage tank supports and other metal shown on this sheet will be paid for under Item (27).
Bridge Railing and railing anchors will be paid for under Item (28)
Gasoline Storage Tank and accessories will be paid for under Item (32).
For additional General Notes see Sheet 6

REFERENCES:

Outlet Works	Sheet 25
Intake Tower	Sheets 34 to 36 incl.
Operating House	Sheets 37 to 39 incl.
Bridge Superstructure Details No. 2	Sheet 54
Piers and Abutment	Sheets 55 and 56
Electrical Equipment	Sheet 57

REVISION	DATE	DESCRIPTION	BY	APPD

CORPS OF ENGINEERS
U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
PHILADELPHIA, PA.

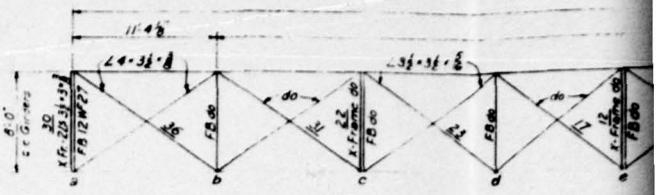
LEHIGH RIVER BASIN - LEHIGH RIVER, PA.
BEAR CREEK RESERVOIR
SERVICE BRIDGE
SUPERSTRUCTURE DETAILS NO. 1

DESIGNED BY G.A.A.
TRACED BY H.S.L.
CHECKED BY J.S.P.
APPROVED J.L.C. SAFETY ENGINEER
SUBMITTED
DATE
APPROVED
COL. C.E. DISTRICT ENGINEER
DATE 18 [illegible]

SHEET 53 OF 73
SCALE: AS SHOWN
DRAWER NO. 281
DRAWING NO 26953

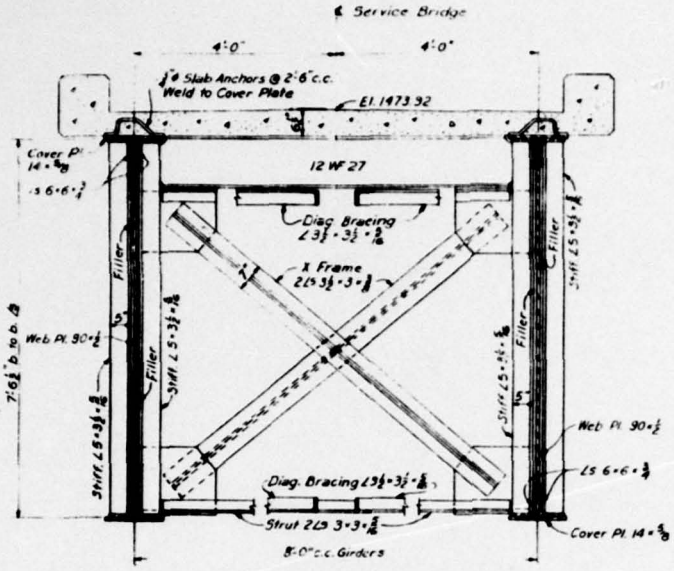
PREPARED IN OFFICE OF THE DISTRICT ENGINEER BALTIMORE DISTRICT

53



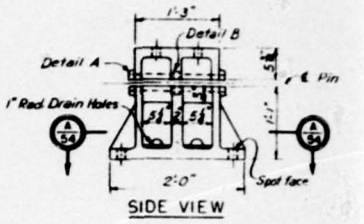
HALF PLAN OF DECK BRACING

SCALE: 3/16 IN. = 1 FT.

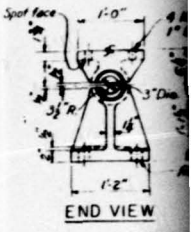


TYPICAL SECTION

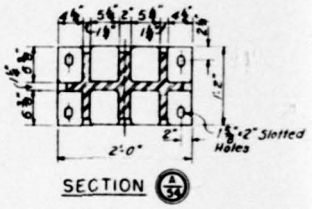
SCALE: 3/4 IN. = 1 FT.



SIDE VIEW



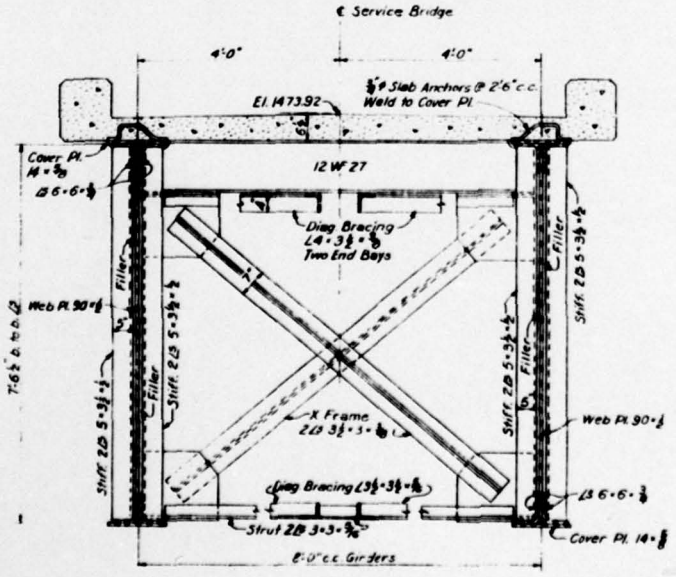
END VIEW



SECTION

FIXED SHOE

SCALE: 1 IN. = 1 FT.



END SECTION

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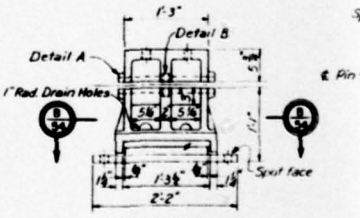

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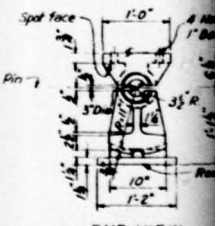
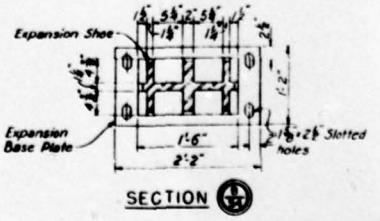


END VIEW



SECTION

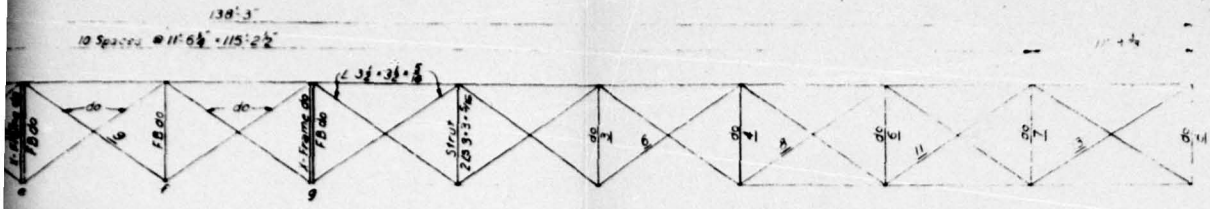
TOOTH DETAIL

NOT TO SCALE

ROCKER SHOE

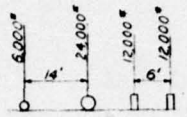
SCALE: 1 IN. = 1 FT.

U.S. ARMY

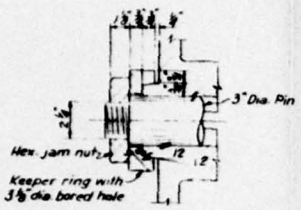


HALF PLAN OF BOTTOM BRACING

SCALE 3/16 IN = 1 FT.



H 15 A.H.S.H.O. TRUCK LIVE LOAD



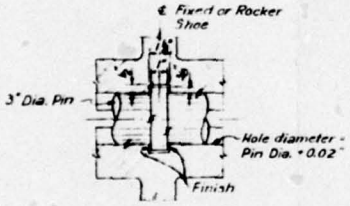
DETAIL A

SCALE: 3 IN. = 1 FT.

DESIGN DATA

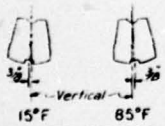
PANEL POINT	SHEAR				MOMENT			
	DEAD LOAD	LIVE LOAD	IMPACT	TOTAL	DEAD LOAD	LIVE LOAD	IMPACT	TOTAL
a.	78.0	16.6	3.2	97.8	0	0	0	0
b.	63.6	"	"	85.4	824	155	29	1,008
c.	52.8	"	"	72.6	1,483	301	57	1,841
d.	39.9	"	"	59.7	1,986	414	79	2,479
e.	27.1	"	"	46.9	2,354	497	94	2,945
f.	14.2	"	"	34.0	2,572	545	104	3,221
g.	1.3	"	"	21.1	2,653	562	107	3,322

Note:
Shear in kips, moments in foot-kips. Stresses in cross framing and struts are shown on the Plan of Bracing and indicated thus: 36, the numeral indicates the stress in kips.

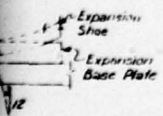


DETAIL B

SCALE: 3 IN. = 1 FT.



ROCKER SETTING



GENERAL NOTES:

Bridge shoes and structural steel shown on this sheet will be paid for under item (21).
All connections shall be riveted except for the gasoline storage tank supports which shall be bolted with ¾" bolts.
Rivets shall be ⅞" ø and open holes 15/16" ø.
Mill vertical stiffeners to bear on top and bottom.
All gusset plates shall be ⅜".
For additional General Notes see Sheet 6

REFERENCES:

For References see Sheet 53

REVISION	DATE	DESCRIPTION	BY	APPD

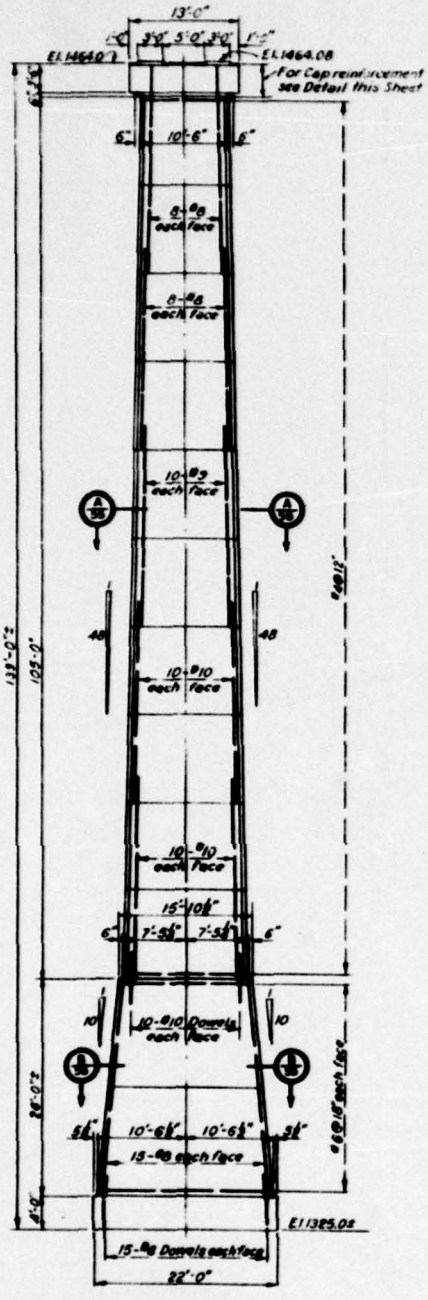
CORPS OF ENGINEERS
U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
PHILADELPHIA, PA.

DRAWN BY G.A.A.	LEHIGH RIVER BASIN - LEHIGH RIVER, PA.
TRACED BY H.S.L.	BEAR CREEK RESERVOIR
CHECKED BY L.S.P.	SERVICE BRIDGE
REVIEWED J.L.G.	SUPERSTRUCTURE DETAILS NO. 2
SUBMITTED	
APPROVED	DATE 1-11-
SHEET 54 OF 73	SCALE: AS SHOWN
DRAWER NO. 281	DRAWING NO. 26954

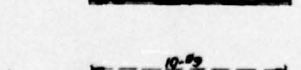
PREPARED BY
OFFICE OF THE DISTRICT ENGINEER
BALTIMORE DISTRICT

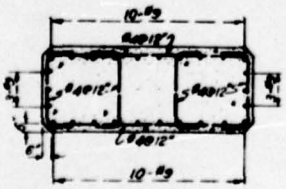
54

CORPS OF ENGINEERS



SIDE ELEVATION
SCALE: 1/8 IN = 1 FT.





SECTION
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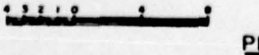
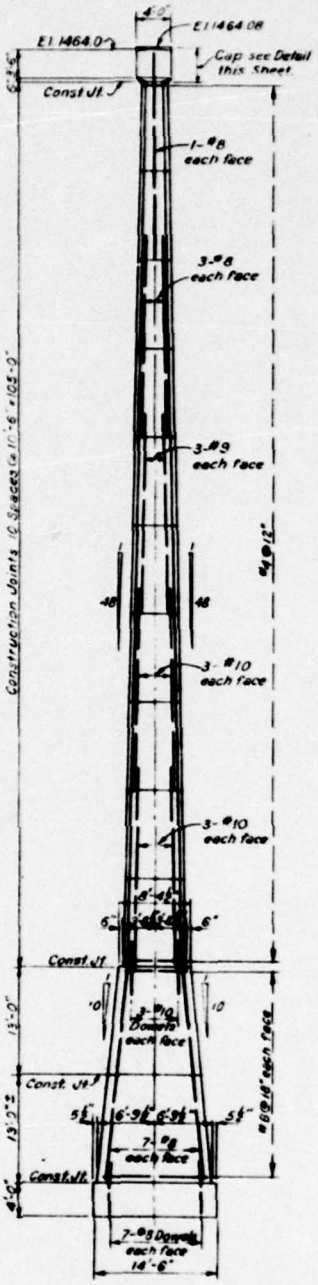
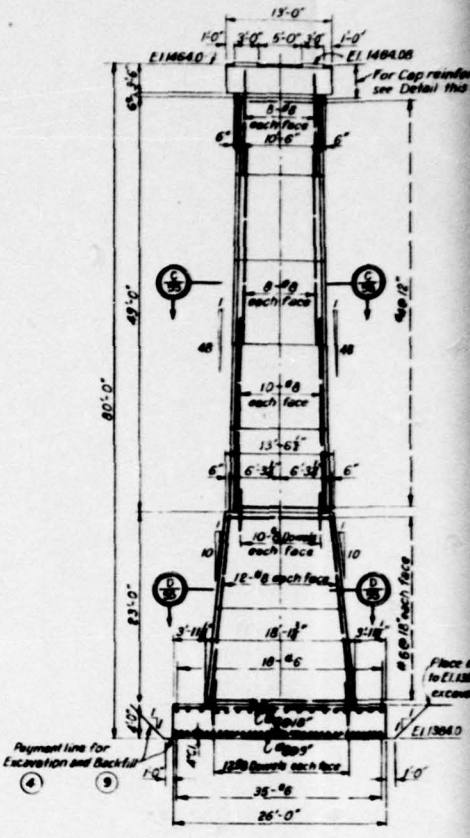




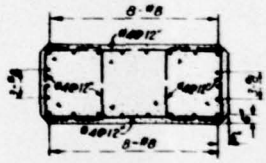
END ELEVATION
SCALE: 1/8 IN = 1 FT.

SECTION
SCALE: 1/4 IN = 1 FT.

PIER NO. 1

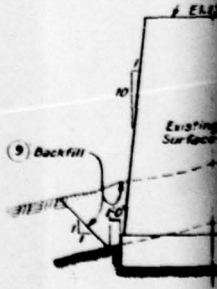


SIDE ELEVATION
SCALE: 1/8 IN = 1 FT.



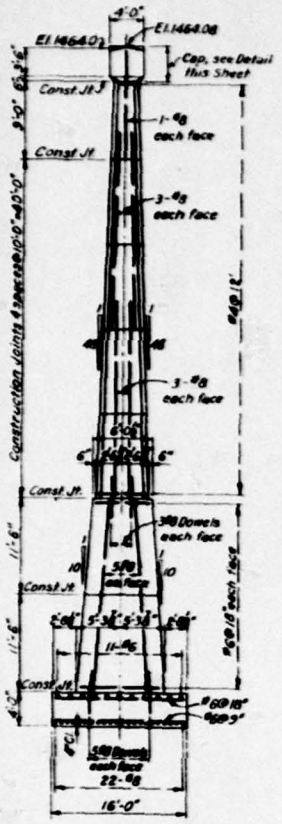
SECTION
SCALE: 1/4 IN = 1 FT.

PIER



EXCAVATION PA

U.S. ARMY



END ELEVATION

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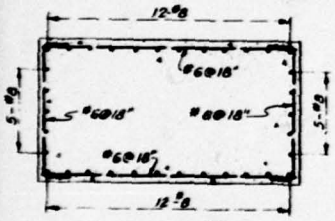
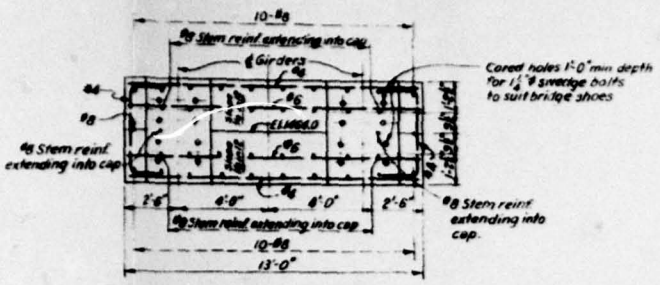
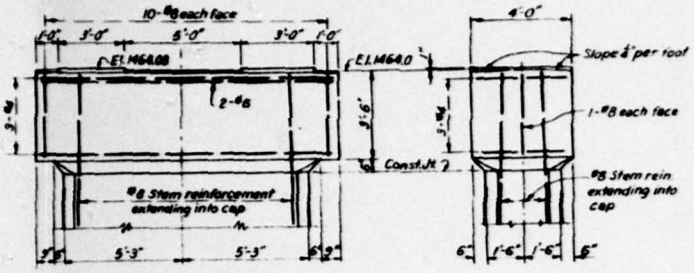


SECTION

SCALE: 1/4 IN. = 1 FT.



PLAN



SIDE ELEVATION

END ELEVATION

CAP DETAIL-PIER NO.1 & PIER NO.2

SCALE: 3/8 IN. = 1 FT.

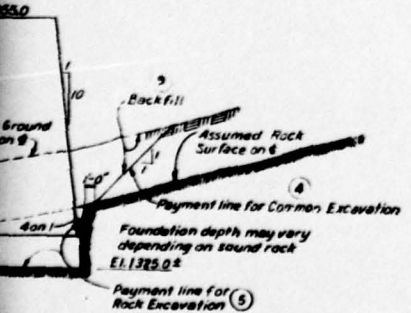
GENERAL NOTES:

Concrete piers and abutment will be paid for under Item (6a).
All exposed edges of concrete shall be chamfered one inch unless otherwise noted or directed.
Steel reinforcement shall be placed with a minimum protective cover of 3 inches unless otherwise noted or directed.
Reinforcing steel splices shall lap 30 diameters unless otherwise noted or directed.
For additional General Notes see Sheet 6

REFERENCES:

For References see Sheet 53

NO 2



YMENT-LINES PIER NO.1

ALE: 1/8 IN. = 1 FT.

REVISION	DATE	DESCRIPTION	BY	APPD

CORPS OF ENGINEERS
U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
PHILADELPHIA, PA.

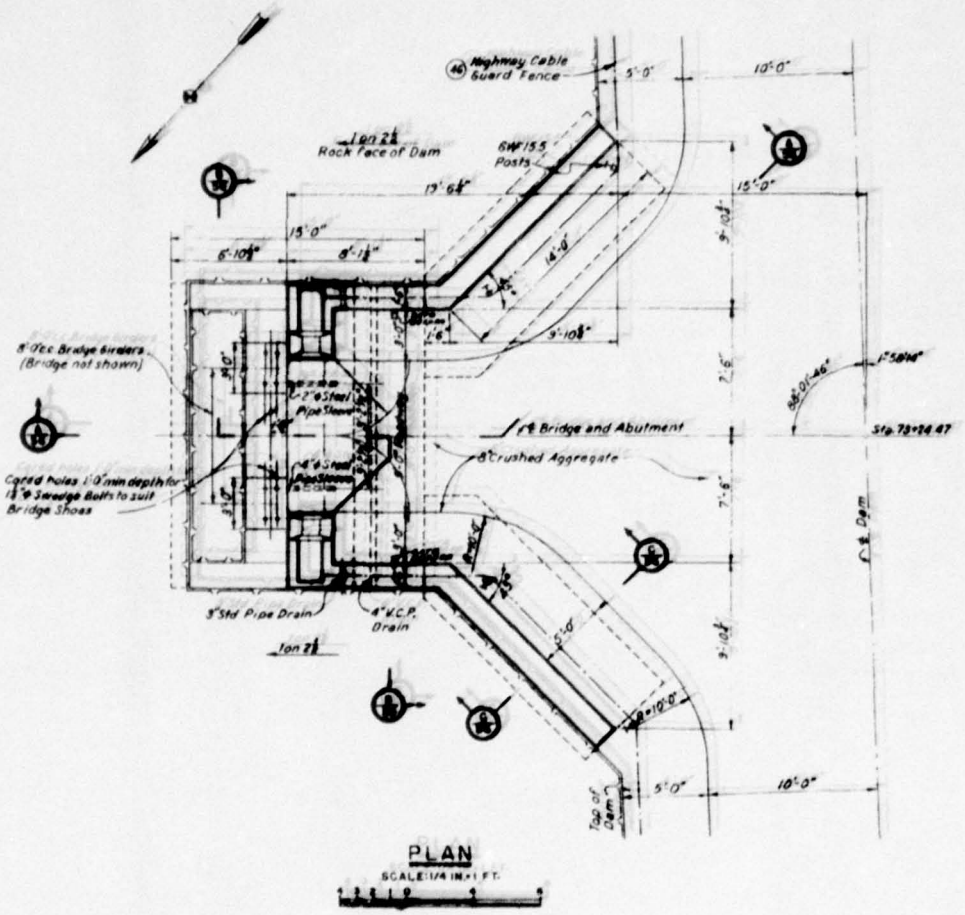
LEHIGH RIVER BASIN - LEHIGH RIVER, PA.
BEAR CREEK RESERVOIR
SERVICE BRIDGE
PIERS

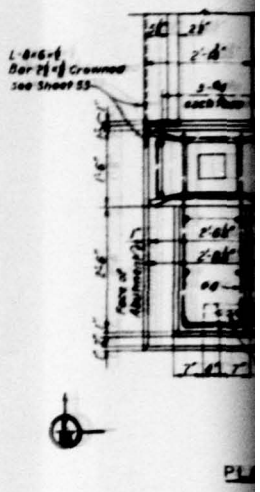
DRAWN BY G. A. A.
TRACED BY S. K.
CHECKED BY R. Z.
REVISED
SUBMITTED
APPROVED
DATE
SCALE: AS SHOWN
SHEET 55 OF 73
DRAWER NO. 281
DRAWING NO. 26955

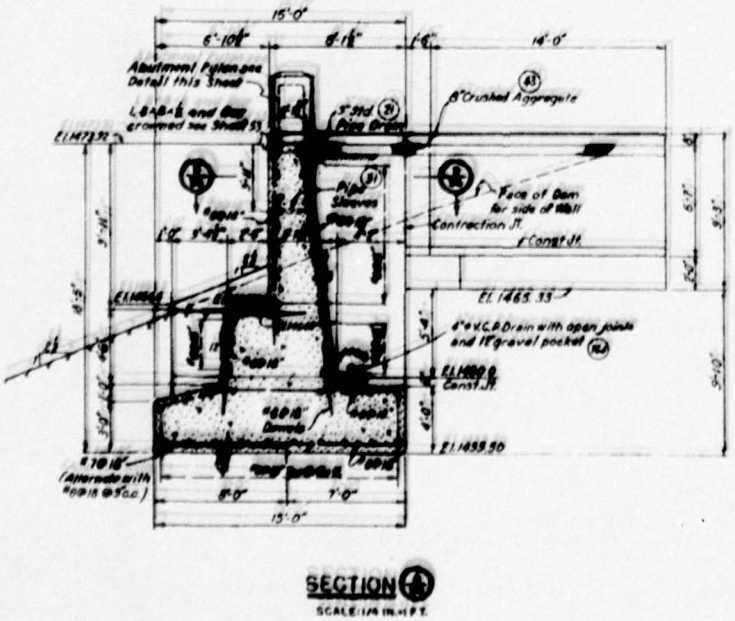
PREPARED BY OFFICE OF THE DISTRICT ENGINEER BALTIMORE DISTRICT

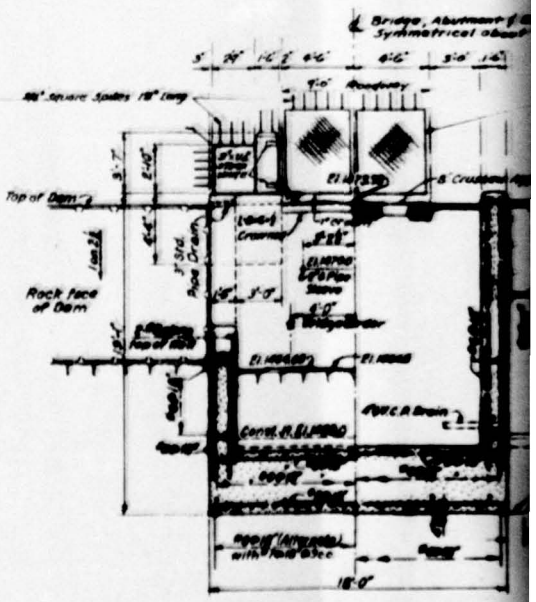
55

CORPS OF ENGINEERS

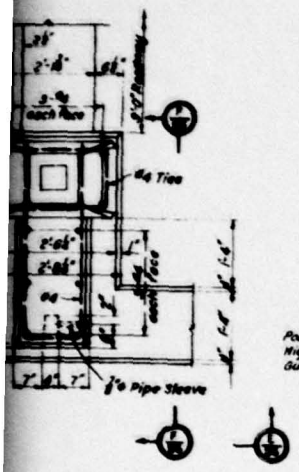




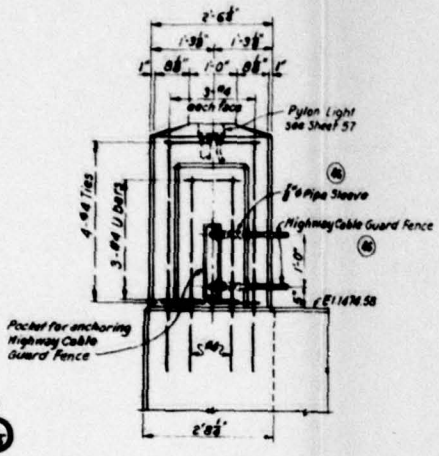




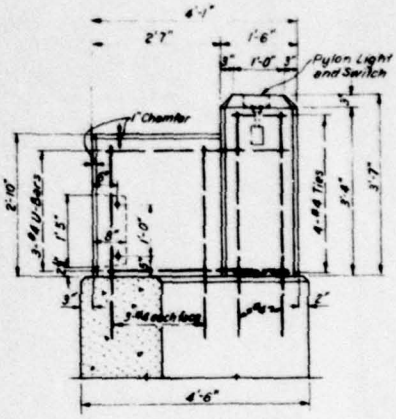
U.S. ARMY



PLAN



SECTION



SECTION

ABUTMENT PYLON DETAIL

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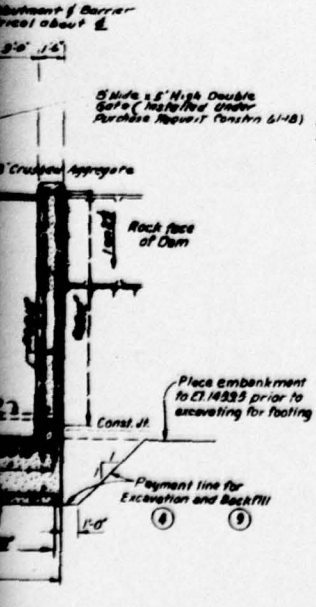

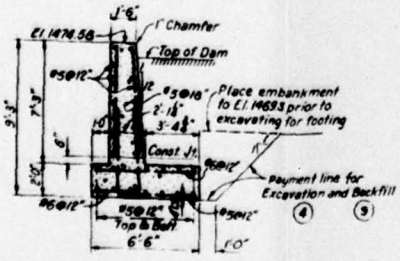

SECTION

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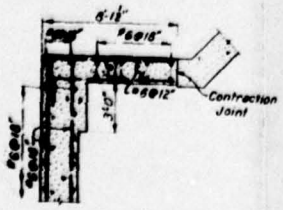


SECTION

SCALE: 1/4 IN. = 1 FT.

GENERAL NOTES:

For General Notes see Sheets 6 and 55

REFERENCES:

For References see Sheet 53

REVISION	DATE	DESCRIPTION	BY	APPD
1	19 JUNE	REVISED TO SHOW AS-BUILT	GD	

CORPS OF ENGINEERS
U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
PHILADELPHIA, PA.

DESIGNED BY	G.A.A.
TRACED BY	G.R.
CHECKED BY	R.Z.
REVIEWED	
QUANTITIES	
APPROVED	

LEHIGH RIVER BASIN - LEHIGH RIVER, PA.
BEAR CREEK RESERVOIR
SERVICE BRIDGE
ABUTMENT

DATE 28 FEB 1961

SHEET 56 OF 73

SCALE: AS SHOWN

DRAWER NO. 281

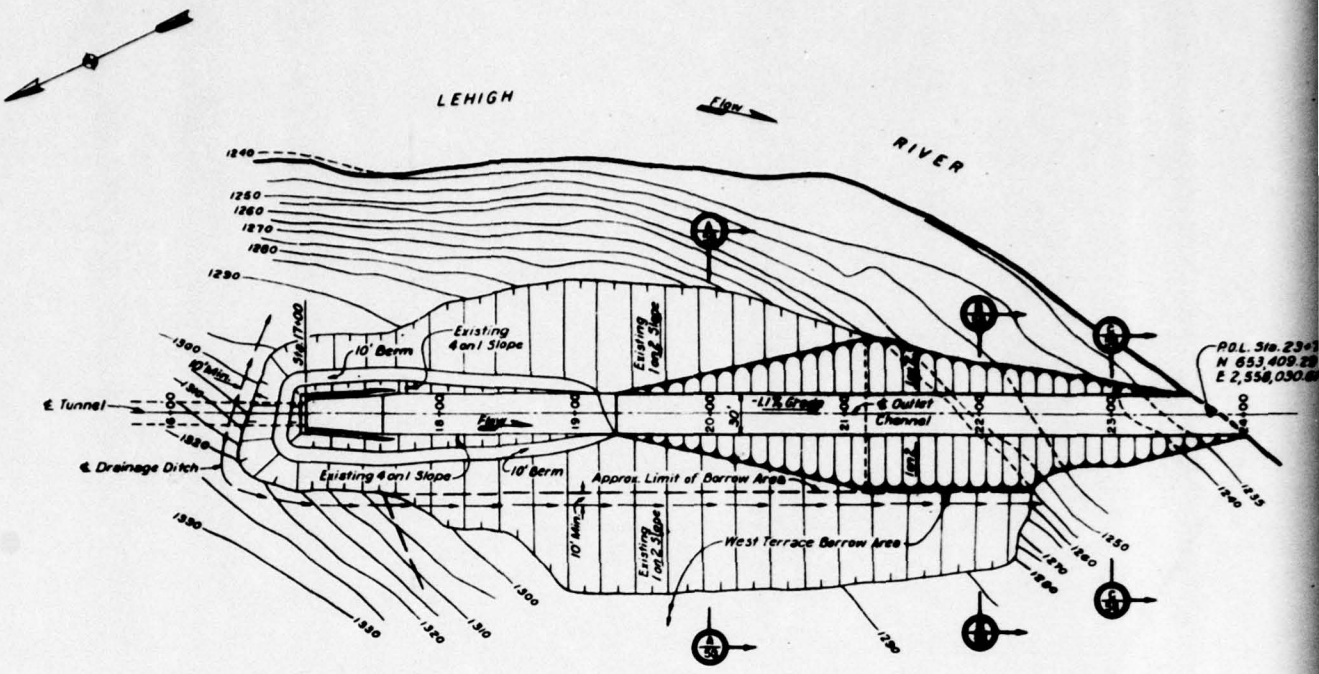
DRAWING NO. 26956

PREPARED BY
OFFICE OF THE DISTRICT ENGINEER
BALTIMORE DISTRICT

ALL OPERATIONS PERFORMED IN ACCOMPLISHING THIS WORK MUST BE DONE IN ACCORDANCE WITH ALL APPLICABLE SAFETY REQUIREMENTS

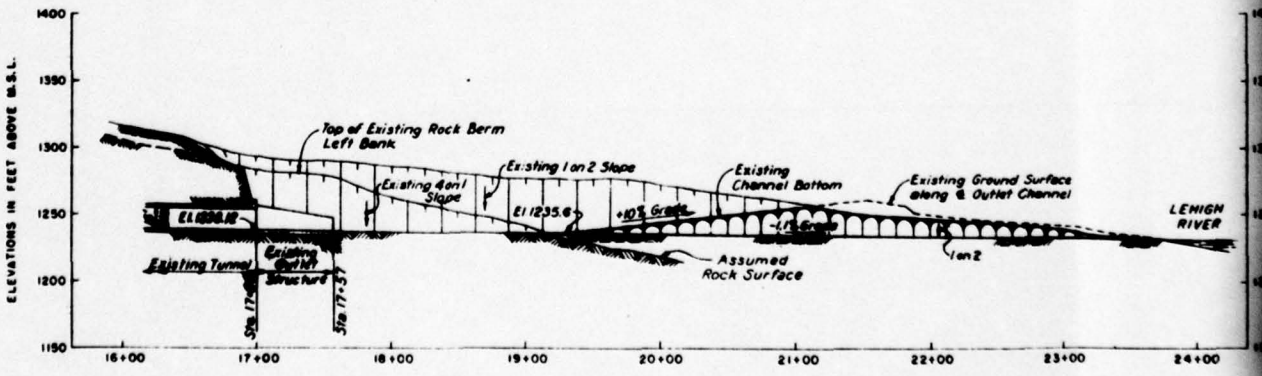
56

CORPS OF ENGINEERS



PLAN

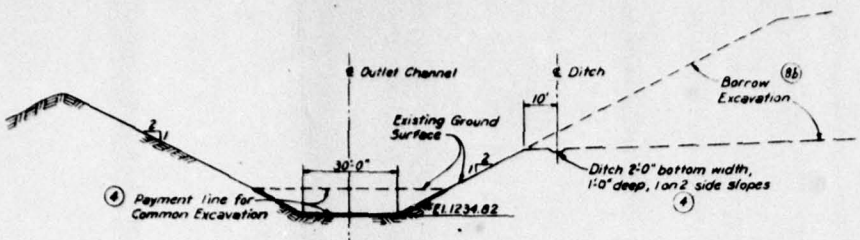
SCALE: 1 IN. = 50 FT.



PROFILE ALONG ℄ OUTLET CHANNEL

SCALE: 1 IN. = 50 FT.

U.S. ARMY



SECTION AT STA. 20+00 (4)

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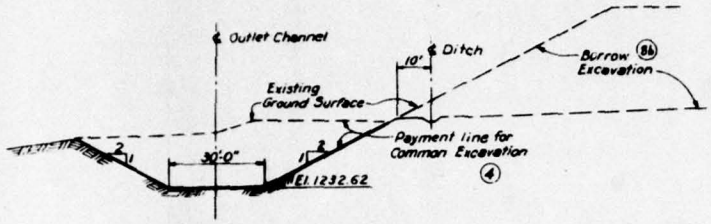
20 0 20 40



SECTION AT STA. 22+00 (4)

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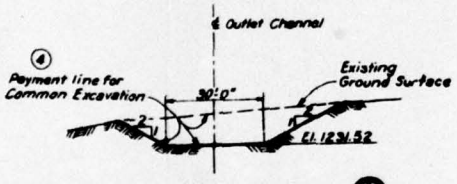


SECTION AT STA. 23+00 (4)

SCALE: 1 IN. = 20 FT.

GENERAL NOTES:

For General Notes see Sheets 6 and 25

REFERENCES

General Plan ..... Sheet 6
Outlet Works ..... Sheet 25

REVISION	DATE	DESCRIPTION	BY	APPD

CORPS OF ENGINEERS
U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
PHILADELPHIA, PA.

DRAWN BY H. H.	LEHIGH RIVER BASIN - LEHIGH RIVER, PA.
TRACED BY H. S. L.	BEAR CREEK RESERVOIR
CHECKED BY H. Z.	OUTLET CHANNEL
REVIEWED J. L. C.	PLAN, PROFILE AND SECTIONS
SUBMITTED	
APPROVED	DATE
SHEET 26 OF 71	SCALE: AS SHOWN
DRAWER NO. 281	DRAWING NO. 26958

PREPARED BY
OFFICE OF THE DISTRICT ENGINEER
PHILADELPHIA DISTRICT

(8b)

APPENDIX D

CONDITION REPORT
FRANCIS E. WALTER DAM
LEHIGH RIVER, PENNSYLVANIA

PERIODIC INSPECTION REPORT NO. 3

INVESTIGATIVE REPORT-MISALIGNMENT OF EXPANSION BEARINGS-SERVICE BRIDGE
DATED SEPTEMBER 1976

FRANCIS E. WALTER DAM
LUZERNE COUNTY
PENNSYLVANIA

INVESTIGATIVE REPORT

MISALIGNMENT OF EXPANSION BEARINGS

SERVICE BRIDGE

SEPTEMBER 1976

Copy No.

INVESTIGATIVE REPORT
MISALIGNMENT OF EXPANSION BEARINGS
SERVICE BRIDGE
FRANCIS E. WALTER DAM

TABLE OF CONTENTS

APPENDICES

Appendix	Title
A	Photographs
B	Exhibits
C	Structural Analysis

SECTION 1
INTRODUCTION

1-01. PURPOSE. This investigation was undertaken as a result of the Northern Area Engineer's request for an engineering determination of the integrity of the service bridge due to an unusual condition observed during a painting contract performed on the bridge in the summer of 1975. At that time, both center span expansion rockers on Pier No. 2, the pier closest to the crest of the dam, were found to be misaligned longitudinally with their base plates and to be in a rotated position. Photographs showing the east girder bearing were made by personnel from the Northern Area Office on 8 July 1975 and were forwarded to Engineering Division by memo dated 24 July 1975. Subsequent photographs showing the condition of both east and west girder bearings were made on 4 August 1975 and were forwarded to Engineering Division by memo dated 13 August 1975. Examination of the photographs indicated that an inspection should be performed by personnel knowledgeable in the design and construction of vehicular bridges in order to determine the cause and effect of the condition upon the structure.

1-02. DESCRIPTION OF STRUCTURE. The service bridge, connecting the intake tower and roadway along the crest of the dam embankment, consists of a three-span, noncontinuous, riveted plate girder superstructure with concrete deck, supported by the intake tower, two intermediate concrete piers, and a concrete abutment at the embankment end.

The bridge was designed as simply supported with each span 138'-3" between bearings. The deck has a roadway width of 9'-0" between curbs and is supported by parallel girders spaced 8'-0" on centers. Fixed bearings are located on the intake tower and piers and rocker type expansion bearings are located on the piers and abutment.

1-03. PREVIOUS INSPECTIONS. Scheduled periodic inspections were made of the project in June 1966 and July 1971. The first periodic inspection report, dated 7-9 June 1966, indicated that no apparent movement of piers and intake tower had occurred since completion but recommended that elevations be established on intake tower and piers in order to determine future settlement or tilting. Survey bench marks were established shortly thereafter on the four lower corners of each pier and tower platform. Initial elevations for these points were included in Table 2 (Exhibit 1, Appendix B) of the second periodic inspection report. It should be noted that the pier number designations in this table appear to be interchanged. In preparation for the second periodic inspection, a follow-up survey was performed during the spring of 1971 and the data collected were also included in this table. The second periodic inspection report, dated July 1971, concluded that the tower and pier settlement study and visual inspection showed no movement had occurred.

On 27 June 1966, an inspection was made of those bearing anchor bolts which were visible from the bridge deck in response to a memo (Exhibit 2, Appendix B), dated 15 June 1966, from Construction-Operations Division reporting loose anchor bolts. The report of that inspection (Exhibit 3, Appendix B) while confirming the presence of loose nuts and protruding anchor bolts, did not mention the condition of the rocker bearings. The report did, however, suggest the possibility that an initial misalignment of the piers caused a problem in setting the anchor bolts. In any case, a follow-up report (Exhibit 4, Appendix B) dated 15 June 1967, indicated that the problem with the anchor bolts had been corrected.

1-04. PHOTOGRAPHIC RECORDS. A search through District photo files was undertaken in an attempt to establish an approximate date for occurrence of the condition since photos of the tower and service bridge had been made during construction and through the intervening years. While most of the bridge photos were made at too great a distance for details of the bearings to be seen, a series of 4"x5" color transparencies, File No. E434, made by the District photographer on 21 October 1965 to record a high reservoir pool, clearly shows a degree of tilt to both rockers on Pier No. 2 consistent with the findings of this investigation and establishes the fact that the condition existed prior to the inspection of loose anchor bolts in June 1966. Photos in the possession of the head dam operator were taken of the loose anchor bolt condition in 1966 and these also show that the rockers on Pier No. 2 are tilted considerably more than the rockers on Pier No. 1.

SECTION 2
INSPECTION

2-01. GENERAL. An inspection of the structure was scheduled for 29 and 30 September 1975 and coordinated through the Resident Engineer, Northern Area. The original plan was to obtain the services of a rental "snooper truck" for close-up inspection of all bridge bearings. However, the width of roadway is too narrow to permit the use of stabilizers required by such equipment. Consequently, services were obtained by the Northern Area Office from a local contractor who provided ladder access to the top of Pier No. 2 from the deck. A scaffold and safety line were also provided along one edge of the pier cap to allow passage under the girders to the interior sides of the bearings. This method worked well and permitted measurements and close-up photographs to be made of the bearing details.

2-02. PERSONNEL. The following District personnel participated in the inspection:

E. Kane, Capt., CoE	Northern Area Office
F. Wildrick	Francis E. Walter Dam
H. Rubright	Engineering Division, Design Br.
J. Posusney	Engineering Division, Design Br.

2-03. OBSERVATIONS AND MEASUREMENTS. A visual survey was made of all structural elements visible from the bridge deck and embankment in an effort to find any signs of abnormalities or pattern of effects that could be related to the problem. With the exception of the expansion bearings on Pier No. 2 and gaps between cover plates at deck joints, nothing exceeding normal construction tolerances was apparent.

A close-up inspection of the bearings on Pier No. 2 was performed from the pier cap. The rockers of both expansion bearings were found to be in a rotated position and displaced longitudinally in the expansion direction with the teeth on the base plates disengaged from the notches in the rocker rims. See Photos #1 through #4, and #7 through #11, Appendix A. The bearing surfaces of the rockers and base plates were found to be in contact across their full widths but the lines of contact were displaced approximately 3 inches off-center towards the fixed bearings. See Photo #12, Appendix A. Measurements of base plate setting and rocker displacement were obtained and degree of rotation computed for both expansion bearings. See Plates 1 and 2. Some anchor bolts were found to be offset relative to center of slotted hole to the extent that very little, if any, adjustment of base plate location could be made. See Photos #5 and #6, Appendix A.

Measurements were also made of the gap between cover plates at all deck joints and are recorded in Plate 3. Also included are additional measurements of these joints obtained at later dates and different temperatures. Punch marks in the cover plates along the centerline were established by Survey Branch personnel at the 5 December 1975 measurement. These marks will provide consistent points for future measurements of expansion/contraction movement and horizontal alignment. The data is recorded in Survey Book 49-108, pages 48-50.

SECTION 3
EVALUATION

3-01. GENERAL CONDITION. With the exception of both expansion bearings on Pier No. 2, the bridge appears to be functioning in a normal manner. All exposed steel surfaces have been recently painted and will probably not require repainting for 7-10 years. No evidence of significant loss of material from corrosion was found and the general physical condition of the structure is good.

3-02. ABNORMAL CONDITIONS. The disengagement of rocker and base plate in each expansion bearing on Pier No. 2 has caused the rim of the rocker at the notch to rest upon the top of the tooth. Rotation of the rocker to allow contraction of the middle span is thereby prevented. Expansion capability for all spans appears to be unaffected.

The gap between cover plates in the deck expansion joint at Pier No. 2 shows no movement with declining temperatures whereas the gaps between cover plates in expansion joints at Pier No. 1 and the abutment show greater than expected widening over the temperature range observed. The summation of widening (total contraction) which occured at the abutment and Pier No. 1 between 30 September 1975 (50^{o}F) and 5 December 1975 (28^{o}F) was about 0.5 inch greater (75 percent) than would be expected for the span lengths involved. On the other hand the total contraction between 5 December 1975 (28^{o}F) and 6 January 1976 (0^{o}F) was exactly what would be expected. The reason for the discrepancy is not clear but could be due to temporary binding of expansion bearings and joints at a temperature higher than 50^{o}F with a delayed release thereby showing an exaggerated contraction for the range between 50^{o}F and 28^{o}F. In view of repainting which took place during the summer of 1975 and the seasonal change occurring, this possiblity has much validity. The summation of cover plate gaps measured on 30 September 1975 at 50^{o}F is approximately 6.5 inches whereas the total width should be 8 inches as shown in the contract drawings for a setting temperature of 50^{o}F. Thus there is an apparent shortage of 1.5 inches in the overall width between cover plates.

Measurements of the expansion bearing base plates relative to the fixed bearing base plates on Pier No. 2 show an average distance of 6 inches between plates. See Plates 1 and 2. The contract drawings indicate the setting distance should have been 5 inches.

The average distance between ends of girders on Pier No. 2 was 4.9 inches at 50^{o}F. See Plates 1 and 2. The contract drawings indicate this distance should be 7 inches at that temperature.

3-03. EFFECT ON STRUCTURE. Contraction of the middle span cannot occur without corresponding deflection of the tops of piers. Measurements of expansion joint cover plate gaps at piers and abutment seem to confirm this to be happening. Considering the flexibility of the piers and the relatively small deflections involved, approximately 0.75 inch to be distributed between both piers, moments at the pier bases and stresses in the girders induced by temperature declines are negligible. See stress calculations, Appendix C.

SECTION 4
SUMMARY

4-01. CONCLUSION. The cause of the condition could not be determined with certainty but several possibilities exist and are discussed below. What has been determined is the fact that the condition has existed for at least 11 years and is not of recent origin.

Consideration of the data obtained strongly suggests a misalignment problem during construction. The overall distance between the centers of bearing at the tower and abutment appears to be too short by 1.5 to 2 inches with most of the shortage occurring between the fixed and expansion bearings of the middle span. This premise would account for the shortage found in the distances between deck joint cover plates and between the ends of the girders on Pier No. 2. Furthermore, when the discrepancies in base plate settings (approximately one inch) previously discussed are combined with the apparent span shortage, the totals very nearly equal the longitudinal displacements measured between the centers of hinge pins and base plates of the rocker bearings. A similar argument could be made if the girders in the middle span were fabricated to longer lengths than called for in the contract drawings, but this is not as likely to have been the case.

Another possible explanation involves the setting of bearings on Pier No. 1. If the distances between fixed and expansion bearings were set greater than required by 1.5 to 2 inches, the effects would be similar to those observed. However, measurements scaled from photographs of the bearings made from the bridge deck in 1966 do not support this concept.

Accurate measurements between centers of all bearing hinge pins, base plates and piers with due consideration of ambient temperature at time of measurement would be required for a conclusive determination. Such a procedure would be difficult and expensive because of inaccessibility to tower and pier bearing seats. Reliance on measurements between deck joint cover plates cannot be made for this purpose since the joints may have been subject to setting adjustments independent of bearing locations.

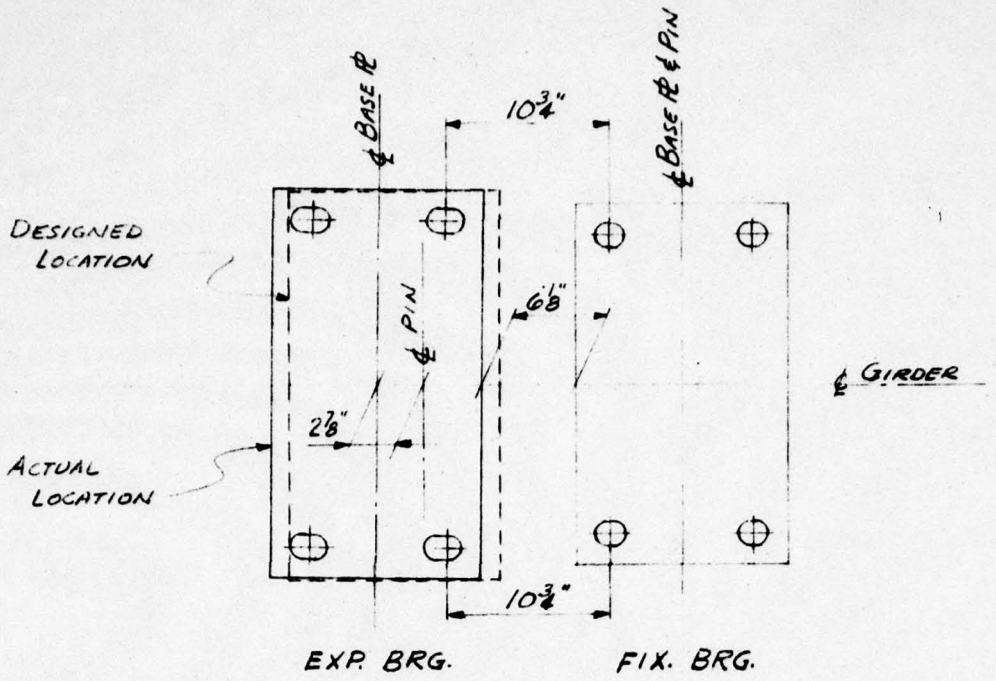
4-02. RECOMMENDATIONS.

a. Corrective Measures. As a result of this investigation, it is concluded that remedial action is not necessary at this time and that the structure may be used to its full design load capacity without harmful stress overloads. However, it is recommended that funds be programmed to correct the condition.

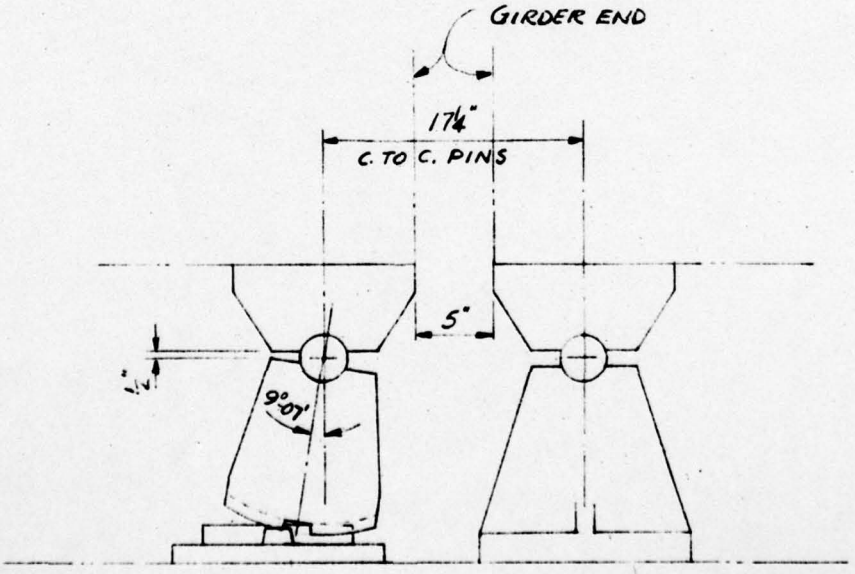
Several methods of alleviating the problem are suggested. Probably the simpliest approach would be to jack the expansion ends of the girders off the base plates, permitting the rockers to hang vertically. The interfering teeth would then be removed by cutting torch and/or grinding and new teeth would be welded into proper position to engage the rocker notches. A variation of this method would be to simply remove the interfering portion of the teeth thereby allowing the rockers to rotate freely in the contracting direction.

Another method to be considered would also require jacking of the girders, allowing repositioning of the expansion shoes on the girder ends to align vertically with the base plates. This would entail removal of shoe mounting bolts and interfering rivets and welding of the shoes in the new position. Relocation or addition of end stiffeners might also be required. This method would eliminate the slight eccentricity occurring on the pier cap from dead load reactions under the present condition.

b. Monitoring. It is recommended that a monthly record of changes in gap width between deck joint cover plates, using established punch marks as reference points, be obtained for a period of one year to provide full record of movement as a base for future observations. It is further recommended that, prior to and in conjunction with each periodic (5 year) inspection, a survey be made to check alignment of the punch marks and elevations on the pier and tower bench marks previously established (Exhibit 1, Appendix B). Additional bench marks should be established and elevations recorded on the deck and abutment. Copies of all data obtained should be forwarded to Design Branch, Engineering Division for evaluation and recording.



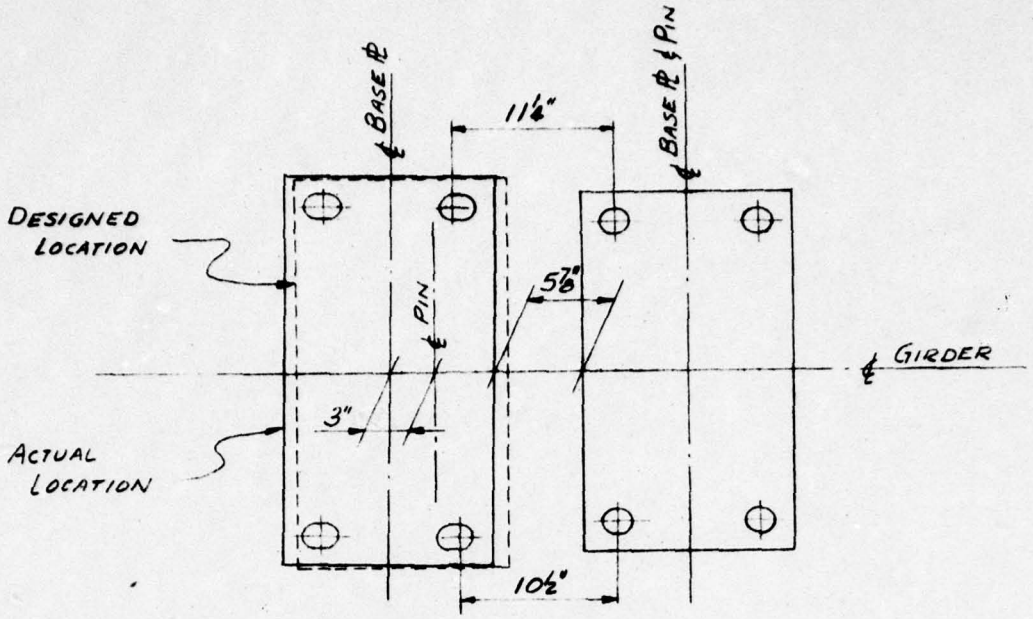
PLAN



ELEVATION

PIER NO. 2 - EAST SIDE
50°F 30 SEPT 1975

PLATE 1



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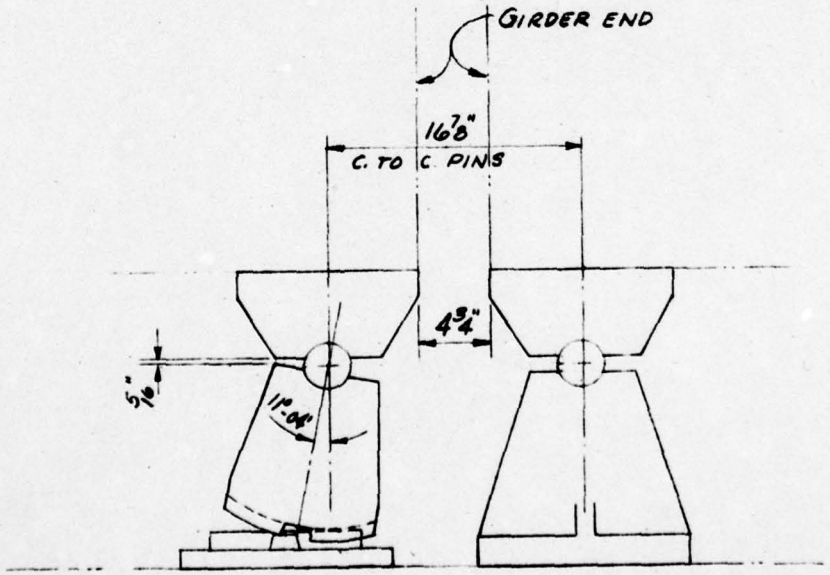


ELEVATION

PIER NO. 2 - WEST SIDE
50°F 30 SEPT 1975

PLATE 2

JOINT MOVEMENT STUDY

DATE	TEMP.	MEASURED DISTANCE BETWEEN COVER PLATES (ins.)					
		TOWER (FIX. JT.)	PIER #1 (EXP. JT.)	PIER #2 (EXP. JT.)	ABUTMENT (EXP. JT.)	TOTAL	Total (Pier #1 and Abutment)
30 Sept. '75	50°F	1.09	2.25	* 1.25	2.00	6.59	4.25
5, Dec. '75	28°F	1.09	2.94	* 1.25	2.56	7.84	5.50
6 Jan. '76	0°F	1.09	3.44	* 1.25	2.97	8.75	6.41
As Designed	50°F	0.50	2.50	2.50	2.50	8.00	5.00

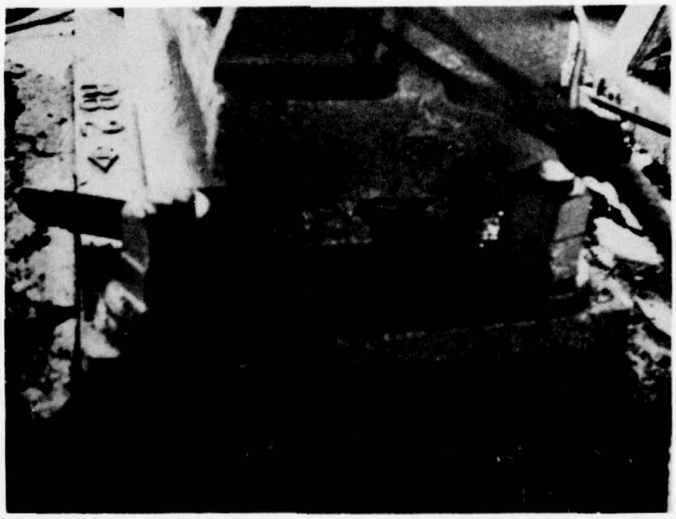
* Indicates no movement

PLATE 3

INVESTIGATIVE REPORT
MISALIGNMENT OF EXPANSION BEARINGS
SERVICE BRIDGE
FRANCIS E. WALTER DAM

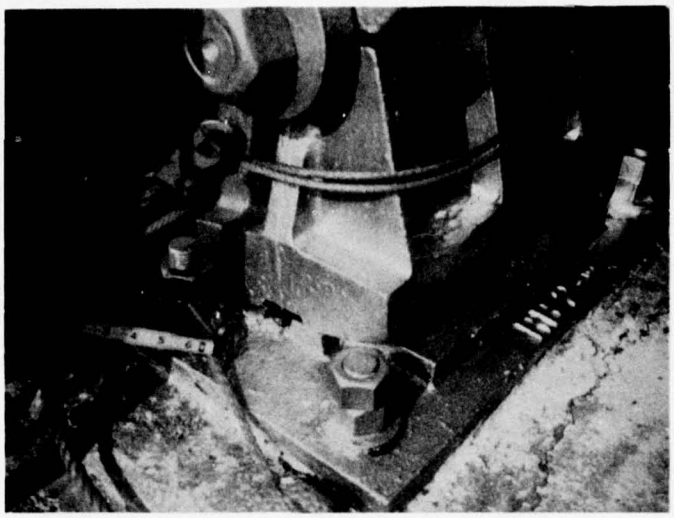
APPENDICES

PIER NO. 2 - EAST SIDE
EXPANSION BEARING (LEFT) SEEN FROM INSIDE GIRDER
PHOTO #1

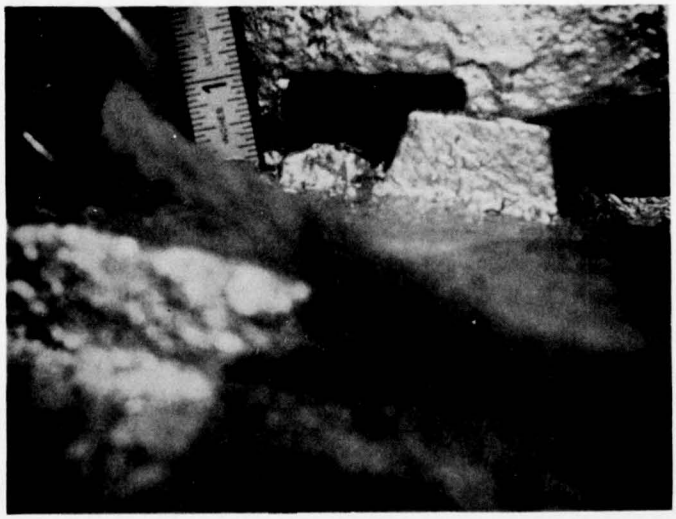


PIER NO. 2 - EAST SIDE
CLOSE-UP OF ABOVE SHOWING DISENGAGEMENT OF ROCKER
AND BASE PLATE
PHOTO # 2

E. KANE
30 Sep 1975

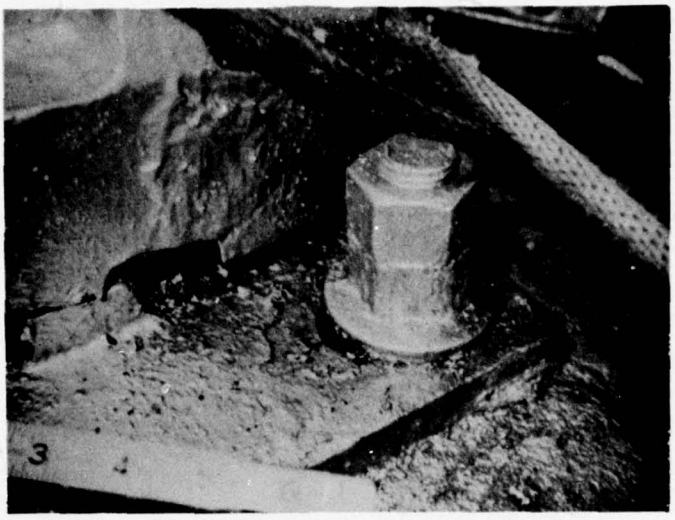


PIER NO. 2-EAST SIDE
EXPANSION ROCKER AND BASE PLATE SEEN FROM
OUTSIDE GIRDER
PHOTO # 3

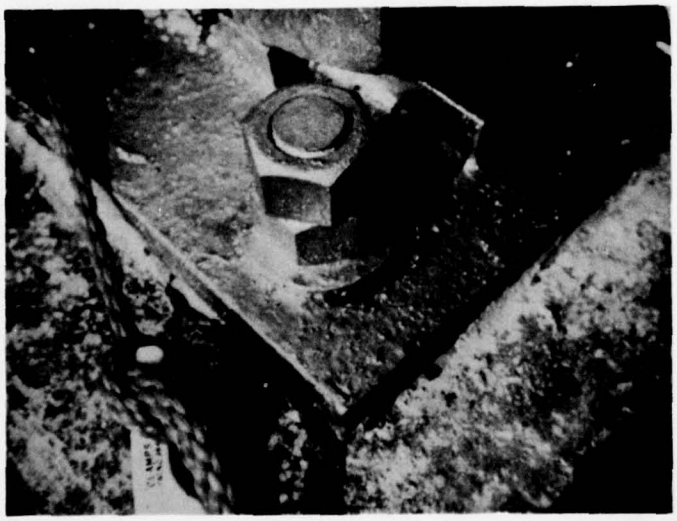


PIER NO. 2-EAST SIDE
CLOSE-UP OF ABOVE SHOWING DISENGAGEMENT
PHOTO # 4

E. KANE
30 Sep 1975

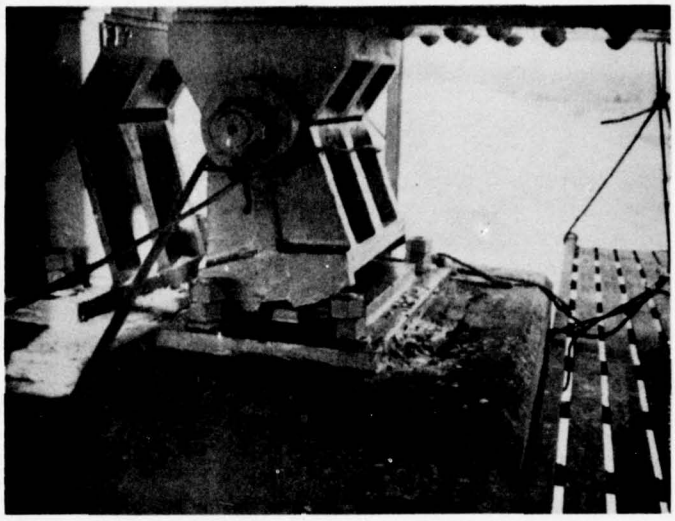


PIER NO. 2-EAST SIDE
CLOSE-UP OF ANCHOR BOLT, INSIDE CORNER OF EXPANSION BEARING
PHOTO #5

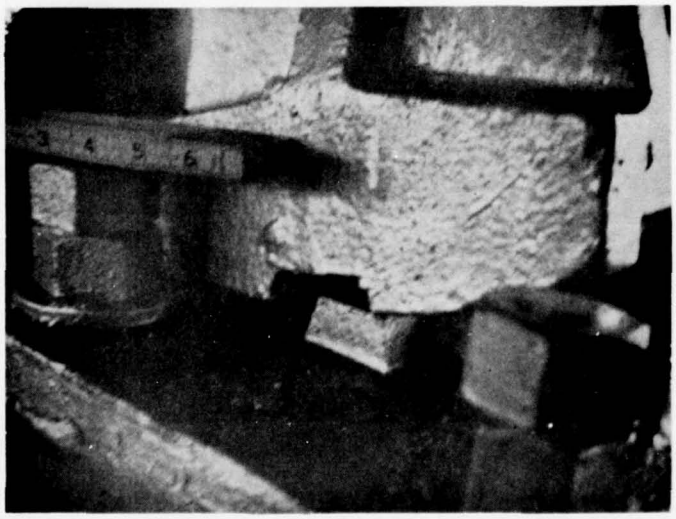


PIER NO. 2-EAST SIDE
CLOSE-UP OF ANCHOR BOLT, OUTSIDE CORNER OF EXPANSION BEARING
PHOTO # 6

E. KANE
30 Sep 1975

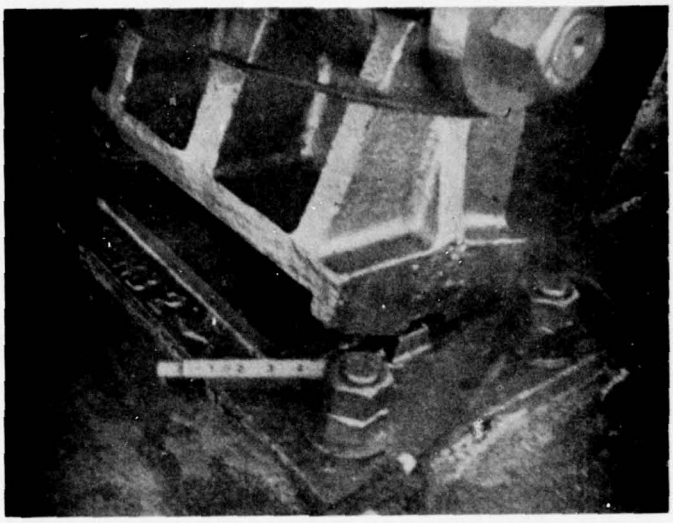


PIER NO. 2-WEST SIDE
EXPANSION BEARING (RIGHT) SEEN FROM INSIDE GIRDER
PHOTO #7

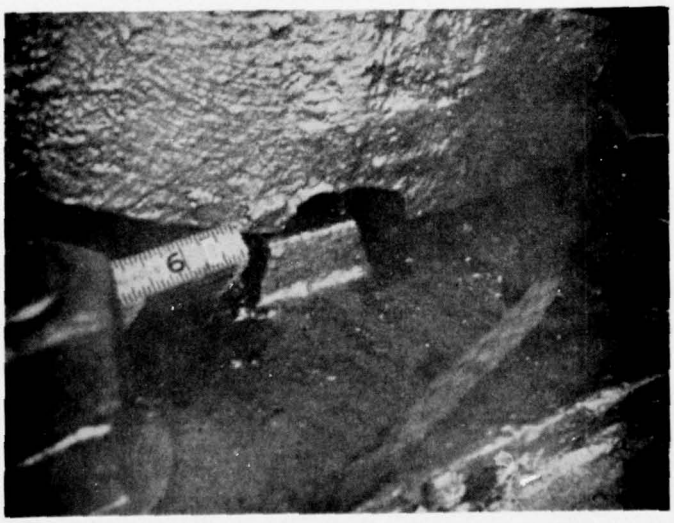


PIER NO. 2-WEST SIDE
CLOSE-UP OF ABOVE SHOWING DISENGAGEMENT OF ROCKER
AND BASE PLATE
PHOTO #8

E. KANE
30 Sep 1975



PIER NO. 2-WEST SIDE
EXPANSION ROCKER AND BASE PLATE SEEN FROM
OUTSIDE GIRDER
PHOTO # 9



PIER NO. 2-WEST SIDE
CLOSE-UP OF ABOVE SHOWING DISENGAGEMENT
PHOTO # 10

E. KANE
30 Sep 1975

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FRANCIS E. WALTER DAM, LEHIGH RIVER BASIN, LEHIGH RIVER, PENNSY--ETC(U)
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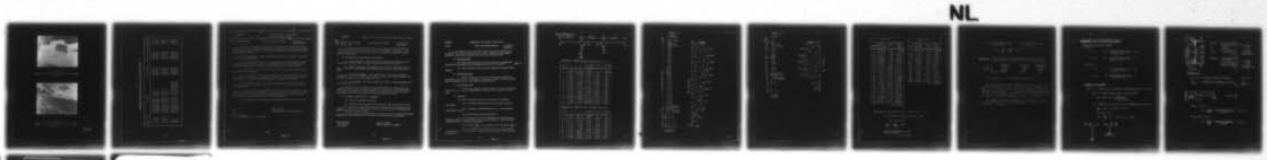

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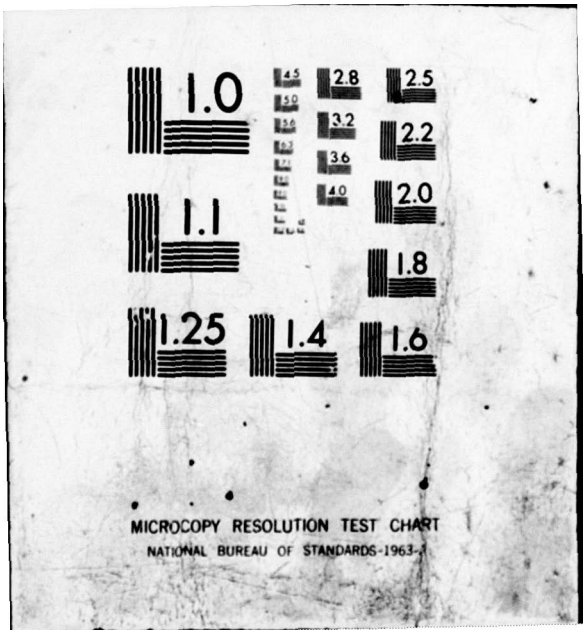
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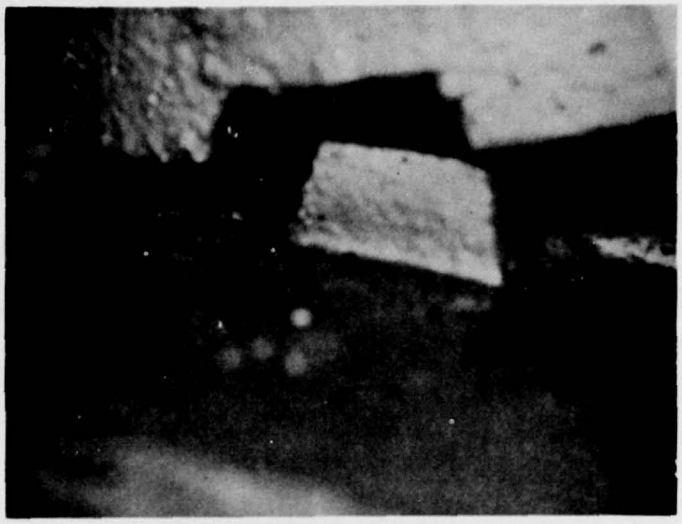
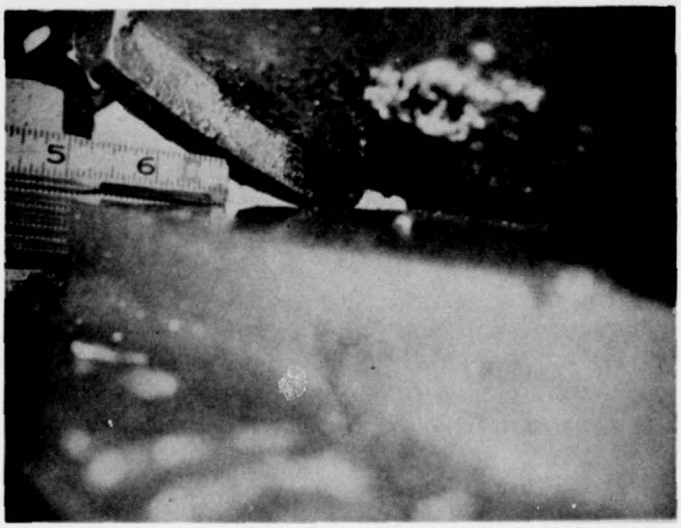
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



PIER NO. 2-WEST SIDE
CLOSE-UP FROM INSIDE GIRDER SHOWING DISENGAGEMENT
PHOTO # 11



PIER NO. 2-WEST SIDE
CLOSE-UP OF BEARING SURFACES OF ROCKER AND BASE
PLATE SHOWING CONTACT LINE TO RIGHT OF CENTER
PHOTO # 12

E. KANE
30 Sep 75

TABLE 2

SUMMARY OF BRIDGE PIER AND TOWER PLATFORM SETTLEMENT

Designation	Location	1966 Elevation	1971 Elevation	Difference
P 1-1	Northeast Corner - Pier 1	1410.857	1410.861	+.004
P 1-2	Northwest Corner - Pier 1	1410.870	1410.878	+.008
P 1-3	Southwest Corner - Pier 1	1410.856	1410.862	+.006
P 1-4	Southeast Corner - Pier 1	1410.840	1410.844	+.004
P 2-1	Northeast Corner - Pier 2	1355.004	1355.008	+.004
P 2-2	Northwest Corner - Pier 2	1355.015	1355.018	+.003
P 2-3	Southwest Corner - Pier 2	1355.082	1355.086	+.004
P 2-4	Southeast Corner - Pier 2	1355.080	1355.084	+.004
TP-1	Northeast Corner - Tower Platform	1308.543	1308.537	-.006
TP-2	Northwest Corner - Tower Platform	1308.521	1308.522	+.001
TP-3	Southwest Corner - Tower Platform	1308.509	1308.512	+.003
TP-4	Southeast Corner - Tower Platform	1308.520	1308.521	+.001

REFERENCE OR OFFICE SYMBOL	SUBJECT
NAPOP-N	Francis E. Walter Dam - Anchor Bolts for Service Bridge

TO	FROM	DATE	CMT 1
Ch, Engineering Div	Act Ch, Operations Div	15 June 66 STARET/km/4741	

1. The Head Dam Operator at Francis E. Walter Dam has reported that the anchor bolts in the expansion and fixed shoes of the spans of the service bridge to the control tower are loose. Details of the anchor bolts are shown on Print 26953, copies attached.

2. The following is a report of the abutments and piers based on observations from the bridge deck.

a. Tower abutment - The 4 outside bolts on the fixed shoes are loose and protrude about 1/8 to 1/4 inch. The edge of the hole in the concrete in which one of the bolts is placed is visible beyond the flange of the shoe.

b. Pier No. 1 - All 8 outside bolts on the 4 shoes are loose and protrude about 2 to 6 inches.

c. Pier No. 2 - All 8 outside bolts on the 4 shoes are loose and protrude about 4 to 10 inches. The edges of the holes in the concrete in which 3 of the bolts are placed are visible outside the flanges of the shoes.

d. Abutment at top of dam - The 4 outside bolts on the 2 shoes are loose and protrude about 1/8 to 1/4 inch. The 4 inside bolts appear to be securely in place.

3. A local contractor has informally proposed repairs by removing all remaining loose material from the holes holding the bolts by chipping and blowing by compressed air, reseating and realigning the bolts and sealing with lead. The contractor's informal price is about $22.00 per bolt.

4. Your comments are requested on the above-mentioned method of repairs.

Incl
as

CARL C. CABLE
Acting Chief, Operations Division

Copy furnished:
Mr. Wildrick, F. E. Walter Dam

Exhibit 2

NAPEN-D Francis E. Walter Dam Anchor Bolts for Service Bridge

XXX
THRU: Chief, Design Branch Ch, Dam Design Section 29 June 1966
TO: Mr. S. Turn Lewis/rmw

1. An inspection of the above access bridge anchorage was made 27 June 1966. The anchorage system includes four bolts per shoe. Each bolt is 1¼"ø and 1'-5" long with 2 hex nuts and a washer. The bolts are placed in cored holes 12 inches deep.

2. The following discrepancies were noted:

a. Tower Abutment. An ungrouted hole approximately 3"ø extends beyond the edge of the shoe. The hole is located near an anchor bolt.

b. Pier Near Bridge. Same comment as a. with the exception that two holes were noted. The nuts on two bolts appear to be three inches above the shoe.

c. Pier Near Abutment. Same comment as a. The nuts on two bolts appear to be two inches above the shoe and in addition, the nuts on another bolt are approximately eight inches above the shoe.

d. Dam Abutment. The nuts on four of the bolts are approximately 3/8" above the shoe.

3. The bolts under the bridge are not visible from the bridge deck, but should be investigated prior to any repair work. It appears that formed holes were provided in the pier for anchor bolts but, during erection of the bridge additional bolt holes were required due to misalignment of piers.

4. Suggested repair work is as follows:

a. All nuts should be tightened.

b. All holes in pier should be filled with a non-shring grout or lead.

c. All bolts which extend more than 5 inches above the shoe should be removed. A 12 inch deep hole will be cored in the pier and a 1'-5" anchor bolt will be grouted or leaded in place.

d. The grouting of anchor bolts should be inspected by removing concrete adjacent to quettionable areas to insure they have been properly grouted.

Copy Furnished
Mr. Dascha
Mr. Lewis

JAMES G. LEWIS
Chief, Dam Design Section

Exhibit 3

NAPEN-D | Inspection of Francis E. Walter Dam

Files | Chief, Dam Design Section | 15 June 67
Lewis/mct

1. A field inspection of the above dam was made on 9 June 1967 by W. Schnoll, W. Zink, C. Besinger and J. Lewis. The following comments pertain to observations made of the outlet works and spillway.

a. Service Bridge

(1) The anchor bolts for the bridge have been removed and reinstalled in accordance with recommendation made 7 July 1966. ←

(2) The condition of the concrete bridge deck appears satisfactory.

b. Intake Structure

Leakage through the horizontal construction joints at the base of the tower is at a minimum. There was approximately one-quarter inch of standing water on the cylinder support floor.

c. Outlet Structure

It has been reported that the outlet portal slab has been undermined to a depth of approximately 18 inches for a distance of three feet.

d. Spillway

(1) The following was noted at the spillway structure:

(a) Spalling of patches at monolith joints along the ogee crest.

(b) Spalling on the downstream side of the horizontal construction joint.

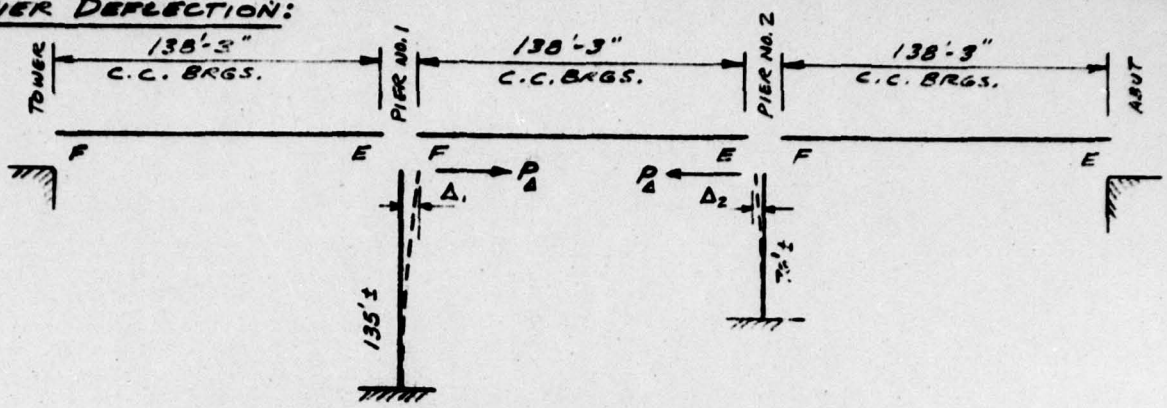
(c) Drain holes plugged with mortar.

(2) The spalled areas of the ogee crest were repaired with concrete; however, the repairs were improperly completed. The following improper methods of patching were noted:

(a) Feather edges were prevalent in the repaired areas.

(b) There was no bond between the patch and the weir. (It appears that the area to be repaired was not kept moist prior to placing patches).

PIER DEFLECTION:

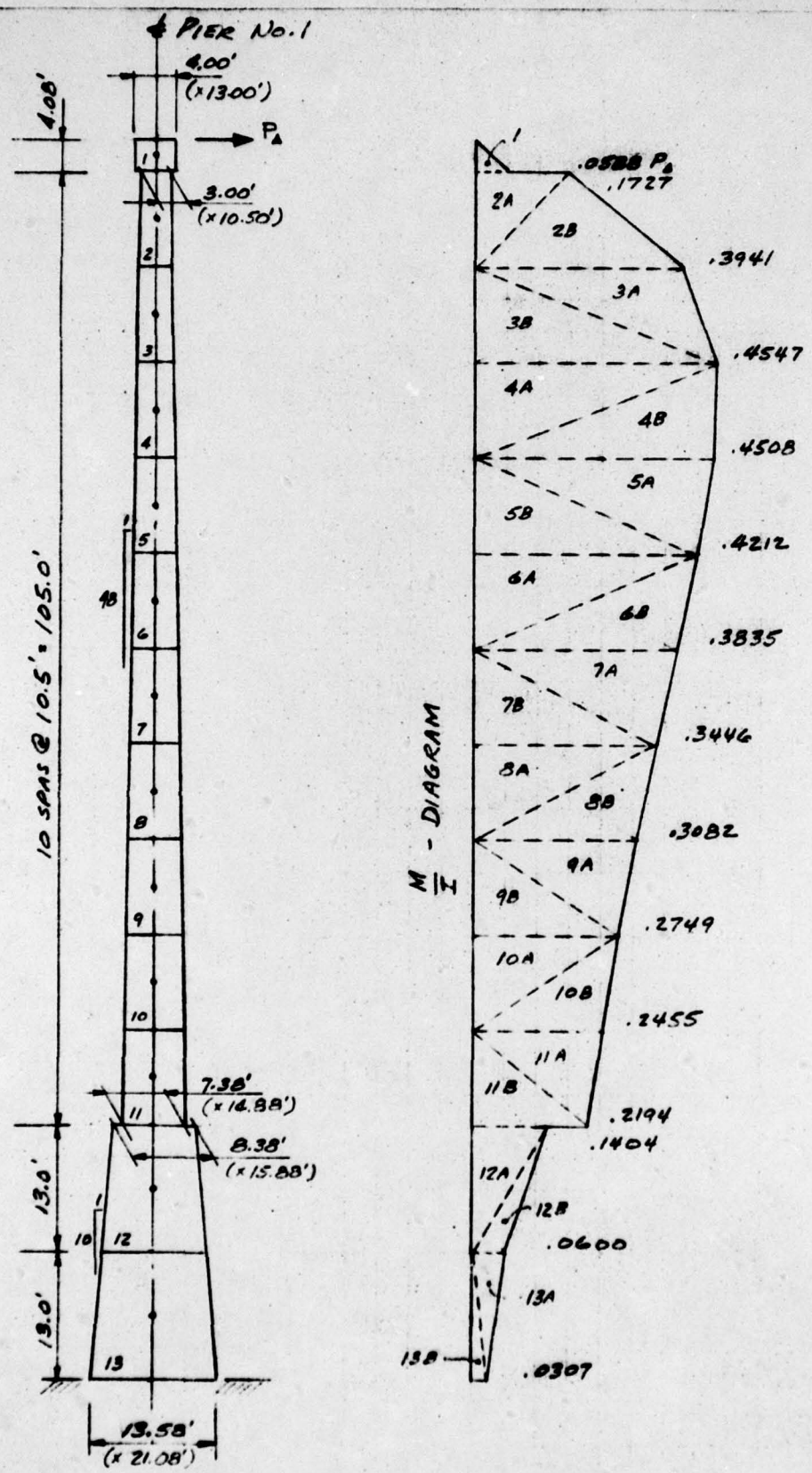


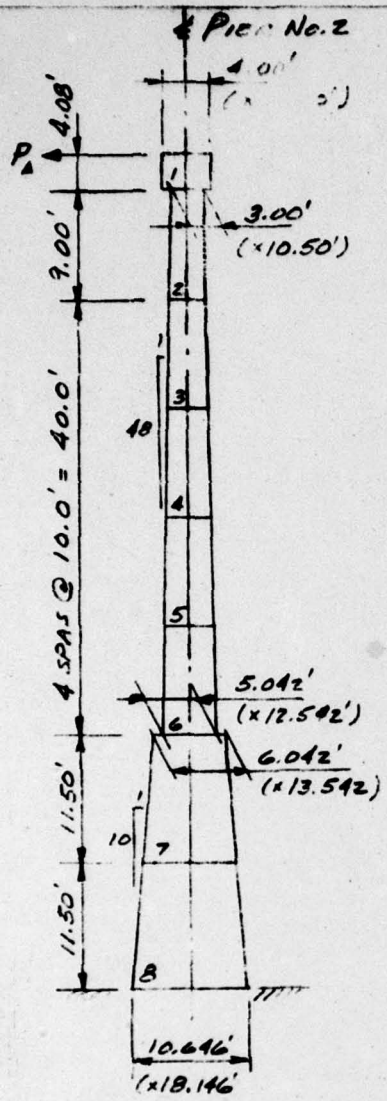
PIER No. 1 - Refer to sht. 2 for dimensions

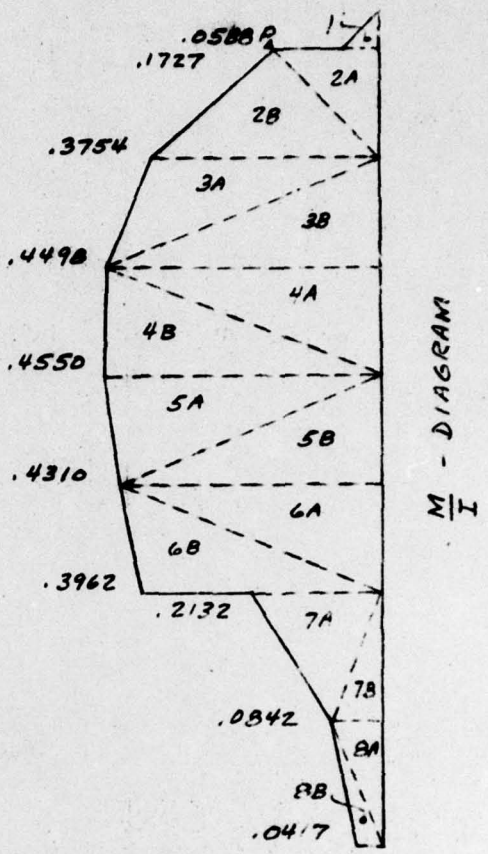
LINE	a	b	$I=\frac{1}{12}a^3b$	M ('#)	$\frac{M}{I}$ ($\#/Ft^3$)
0	4.000	13.000	69.33	0	0
1	4.000	13.000	69.33	4.08 P	.0588 P_Δ
1	3.000	10.500	23.62	4.08	.1727
2	3.437	10.937	37.00	14.58	.3941
3	3.875	11.375	55.16	25.08	.4547
4	4.312	11.812	78.92	35.58	.4508
5	4.750	12.250	109.40	46.08	.4212
6	5.187	12.687	147.55	56.58	.3835
7	5.625	13.125	194.66	67.08	.3446
8	6.062	13.562	251.76	77.58	.3082
9	6.500	14.000	320.40	88.08	.2749
10	6.937	14.437	401.62	98.58	.2455
11	7.375	14.875	497.24	109.08	.2194
11	8.375	15.875	777.12	109.08	.1404
12	10.975	18.475	2035.25	122.08	.0600
13	13.575	21.075	4393.45	135.08	.0307

PIER No. 2 - Refer to sht. 3 for dimensions

LINE	a	b	$I=\frac{1}{12}a^3b$	M ('#)	$\frac{M}{I}$ ($\#/Ft^3$)
0	4.000	13.000	69.33	0	0
1	4.000	13.000	69.33	4.08 P	.0588 P_Δ
1	3.000	10.500	23.62	4.08	.1727
2	3.375	10.875	34.84	13.08	.3754
3	3.792	11.292	51.31	23.08	.4498
4	4.208	11.708	72.70	33.08	.4550
5	4.625	12.125	99.96	43.08	.4310
6	5.042	12.542	133.97	53.08	.3962
6	6.042	13.542	248.91	53.08	.2132
7	8.344	15.844	747.02	64.58	.0842
8	10.646	18.146	1824.56	76.08	.0417


℄ PIER No. 1
4.00'
(×13.00')
4.00'
P_A
3.00'
(×10.50')
10 SPANS @ 10.5' = 105.0'
4B
7.38'
(×14.88')
8.38'
(×15.88')
13.0'
13.0'
13.58'
(×21.08')
M/I - DIAGRAM
.0588 P_A
.1727
.3941
.4547
.4508
.4212
.3835
.3446
.3082
.2749
.2455
.2194
.1404
.0600
.0307


Pier No. 2
4.00'
4.08'
P
3.00'
3.00'
(×10.50')
4 SPANS @ 10.0' = 40.0'
48
5.042'
(×12.542')
6.042'
(×13.542')
11.50'
10
11.50'
10.646'
(×18.146')


.0588 P
.1727
2A
2B
.3754
3A
3B
.4498
4A
4B
.4550
5A
5B
.4310
6A
6B
.3962
.2132
7A
7B
.0842
8A
8B
.0417
M/I - DIAGRAM

PIER NO. 1			
AREA	AREA OF $\frac{M}{I}$ ($\#/ft^2$)	MOMENT ARM	MOMENT ($\#/Ft$)
1	$0.1200 P_\Delta$	2.72	$0.326 P_\Delta$
2A	0.9067	7.58	6.873
2B	2.0690	11.08	22.925
3A	2.0690	18.08	37.408
3B	2.3872	21.58	51.516
4A	2.3872	28.58	68.226
4B	2.3667	32.08	75.924
5A	2.3667	39.08	92.491
5B	2.2113	42.58	94.157
6A	2.2113	49.58	109.636
6B	2.0134	53.08	106.871
7A	2.0134	60.08	120.965
7B	1.8091	63.58	115.023
8A	1.8091	70.58	127.686
8B	1.6180	74.08	119.861
9A	1.6180	81.08	131.187
9B	1.4432	84.58	122.066
10A	1.4432	91.58	132.168
10B	1.2889	95.08	122.549
11A	1.2889	102.08	131.571
11B	1.1518	105.58	121.607
12A	0.9126	113.41	103.498
12B	0.3900	117.75	45.922
13A	0.3900	126.41	49.300
13B	0.1995	130.74	26.083

$\Sigma = 2135.84 P_\Delta$

PIER NO. 2			
AREA	AREA OF $\frac{M}{I}$ ($\#/ft^2$)	MOMENT ARM	MOMENT ($\#/Ft$)
1	$0.1200 P_\Delta$	2.72	$0.326 P_\Delta$
2A	0.7771	7.08	5.502
2B	1.6893	10.08	17.028
3A	1.8770	16.41	30.802
3B	2.2490	19.75	44.418
4A	2.2490	26.41	59.396
4B	2.2750	29.75	67.681
5A	2.2750	36.41	82.833
5B	2.1550	39.75	85.661
6A	2.1550	46.41	100.014
6B	1.9810	49.75	98.555
7A	1.2259	56.91	69.766
7B	0.4841	60.75	29.409
8A	0.4841	68.41	33.117
8B	0.2398	72.25	17.326

$\Sigma = 741.83 P_\Delta$

Temperature Range 60°F to -10°F (Contraction)

$$\Delta_T = 0.65 \times 10^{-5} \times 138.25 \times 12 \times 70 = 0.75"$$

$$\Delta_1 + \Delta_2 = 0.75$$

$$\Sigma \frac{M}{EI_1} + \Sigma \frac{M}{EI_2} = 0.75$$

$$\frac{(2135.84 + 741.83) P_\Delta}{(3.1 \times 10^6) 12} = 0.75$$

$$P_\Delta = 9.70^K$$

$$\Delta_1 = \frac{2135.84 \times 9700}{3.1 \times 10^6 \times 12} = 0.56" \qquad \Delta_2 = \frac{741.33 \times 9700}{3.1 \times 10^6 \times 12} = 0.19"$$

$$\text{Ratio } \frac{\Delta_1}{\Delta_2} = \frac{0.56}{0.19} = 2.95$$

REMARKS: Observed exp. jt. cover plate gaps for period 5 Dec '75 (28°F) to 6 Jan '76 (0°F) are as follows:

	Pier No. 1	Pier No. 2	Abutment
5 Dec '75	2.94"	1.25	2.56
6 Jan '76	3.44	1.25	2.97
Change	+0.50	None	+0.41

$$\Delta_T \text{ per span} = 0.65 \times 10^{-5} \times 139.25 \times 12 \times 28 = 0.30"$$

No movement occurred at Pier No. 2, therefore, expansion joints at Pier No. 1 and Abutment must have absorbed all change due to contraction. Since each span contracted approx. 0.30" (widened joint), the distribution of movement for the center span was 0.20" (.50 - .30) at Pier No. 1 and 0.11" (.41 - .30) at Abutment, or a ratio of 1.82 to 1.

This agrees reasonably with the predicted ratio 2.95 to 1 (0.22" at Pier No. 1 and 0.08" at Abutment) given by the preceding analysis.

STRESSES INDUCED BY MISALIGNMENT

BENDING STRESS IN PIERS

PIER NO. 1

Line 11 $$f_c = \frac{9.70 \times 10^3 \times 109.08 \times 3.69}{497.24 \times 144} = 55 \text{ PSI}$$

Line 13 $$f_c = \frac{9.70 \times 10^3 \times 135.08 \times 6.79}{4393.45 \times 144} = 14$$

PIER NO. 2

Line 6 $$f_c = \frac{9.70 \times 10^3 \times 53.08 \times 2.52}{133.97 \times 144} = 67$$

Line 8 $$f_c = \frac{9.70 \times 10^3 \times 76.08 \times 5.32}{1824.56 \times 144} = 15$$

STRESS IN GIRDERS

Rolling and Frictional force from rocker bearings in end spans.

Ref. PennDOT Design Manual 4, pg 4.6.50

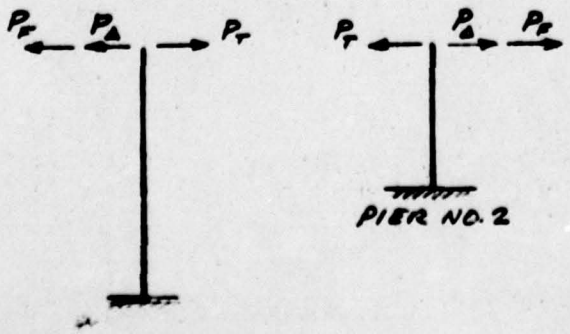
$$P_F = 0.25 \times DL \times \frac{r \text{ (rod. pin)}}{R \text{ (rod. rocker)}}$$

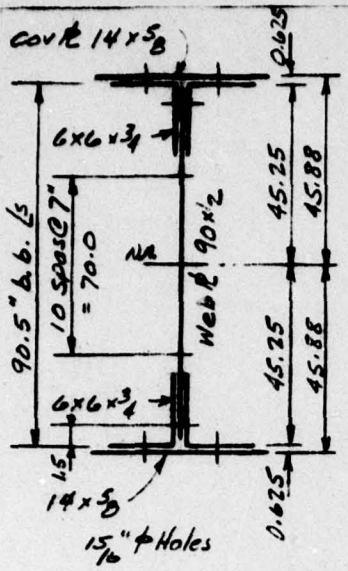
DL = ± 78^k per rocker brg. (Ref. Dwg. #26954, Sht. 54 of 73)

$$P_F = 0.25 \times 78 \times \frac{1.5}{11} = 2.66^k$$

$$P_T = P_\Delta + P_F$$

$$P_T = \frac{9.7}{2} + 2.7 = 7.6^k \text{ per girder}$$





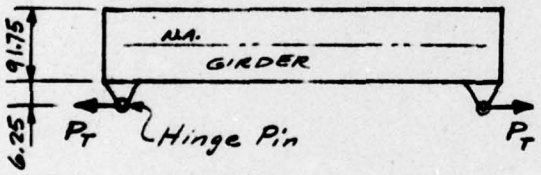
Cov. PLs	$2(1/12)(14)(.625)^3$	= 1
	$2(14)(.625)(45.56)^2$	= 36,325
Ls	$2(56.4)$	= 113
	$2(16.90)(43.47)^2$	= 63,870
Web PL	$(1/12)(.50)(90.0)^3$	= 30,375
	I_{Gross}	= 130,684 in⁴
15/16 ϕ Holes	$2(.50)(.938)(7^2+14^2 \ldots$	
	$\ldots+21^2+28^2+35^2)$	= -2,528
	$2(2.0)(.938)(43.75)^2$	= -7,182
	$4(.938)(1.375)(45.19)^2$	= -10,535
	I_{Net}	= 112,967 in⁴

GIRDER SECT.

$$A_{Gross} = 2(14)(.625) + 2(16.90) + 0.50(90.0) = 96.3 \text{ in}^2$$

$$A_{Holes} = 11(.50)(.938) + 2(2.0)(.938) + 4(.938)(1.375) = -14.1$$

$$A_{Net} = 82.2 \text{ in}^2$$



$$s = \frac{P}{A} \pm \frac{Mc}{I}$$

Tension (Bot.)

$$s_t = \frac{7600}{82.2} + \frac{7600(52.13)(45.88)}{112,967} = 253 \text{ psi}$$

Compression (Top)

$$s_c = \frac{7600}{82.2} - \frac{7600(52.13)(45.88)}{130,684} = -47 \text{ psi}$$

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1. REPORT NUMBER: COE/NAP/FEWD/PIS/no.3/11-76
2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER: 9

4. TITLE (and Subtitle): Francis E. Walter Dam, Lehigh River Basin, Lehigh River, Pennsylvania. Condition Report. Dam, Outlet works and spillway. Periodic inspection report no. 3
5. TYPE OF REPORT & PERIOD COVERED: Periodic inspection report, no. 3, for period ending Nov 76. Nov. 1976
6. PERFORMING ORG. REPORT NUMBER: COE/NAP/FEWD/PIS/NO.3/11-76

7. AUTHOR(s): U.S. Army Corps of Engineers, Philadelphia District
8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS: U.S. Army Corps of Engineers Philadelphia District, 2nd & Chestnut Sts., Philadelphia, Penna. 19106
10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS: same
12. REPORT DATE: 11 June 1977
13. NUMBER OF PAGES: 55

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Francis E. Walter Dam	Structural analysis	Dam safety
Lehigh River, Pa	Spillways	Lehigh River Basin
Outlet works	Embankments	
Dam inspection	Seepage	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The third periodic inspection of Francis E. Walter Dam was held on 10 Nov. 1976 by representatives of the North Atlantic Division and the Philadelphia District Corps of Engineers. The service bridge, intake tower, outlet slab, discharge channel, embankment, spillway and upstream reservoir area of this dam were inspected by direct visual observation and instrumentation analysis. The overall condition of the project is considered good.

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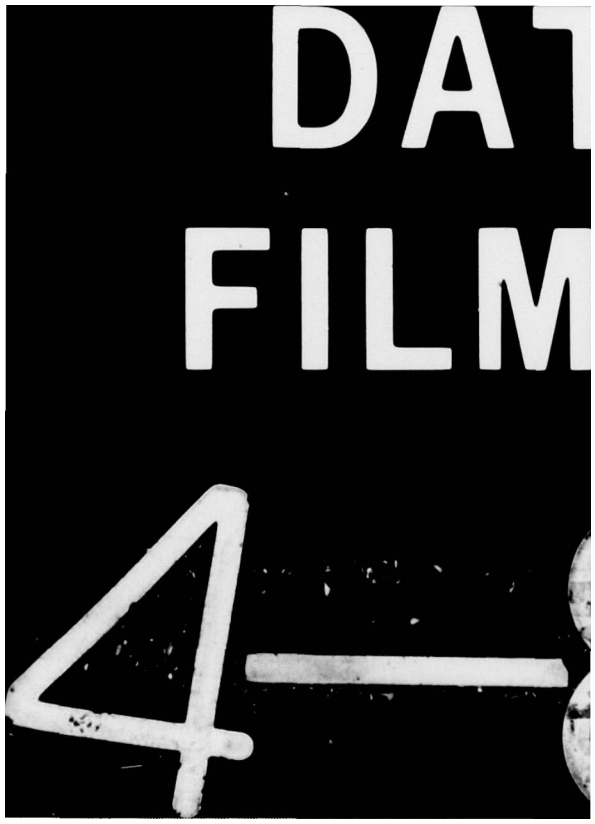
Some slope irregularities were observed and additional use of inclinometers was requested to monitor the upstream and downstream slopes. Minor remedial repair work can be accomplished by routine maintenance.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